
Geomorphic Data Summary Report

Restoration Plan for the Clark Fork River and Blackfoot River near Milltown Dam

December 2006

Prepared For:

State of Montana
Natural Resource Damage Program and
Montana Fish, Wildlife & Parks
In consultation with the U.S. Fish and Wildlife Service and
Confederated Salish and Kootenai Tribes



Prepared By:

River Design Group, Inc.
5098 Highway 93 South
Whitefish, Montana 59937



WestWater Consultants, Inc.
1112 Catherine Lane
Corvallis, MT 59828



State of Montana Natural Resource Damage Program

Geomorphic Data Summary Report

Restoration Plan for the Clark Fork River and Blackfoot River near Milltown Dam

December 2006

Prepared For:

State of Montana
Natural Resource Damage Program and
Montana Fish, Wildlife & Parks
In consultation with the U.S. Fish and Wildlife Service and
Confederated Salish and Kootenai Tribes

Prepared By:

River Design Group, Inc.
5098 Highway 93 South
Whitefish, Montana 59937

WestWater Consultants, Inc.
1112 Catherine Lane
Corvallis, Montana 59828

EXECUTIVE SUMMARY

Section 1. Introduction	1
1.1 Objectives	1
1.2 Study Reaches	1
1.3 Document Organization	3
Section 2. Methods	3
2.1 Channel Cross-section and Longitudinal Profile	4
2.2 Planform Geometry	4
2.3 Substrate Characterization	5
2.4 Bank Erosion Prediction	5
2.5 Data Processing	6
Section 3. Results	7
Section 4. Water Year 2005 and Water Year 2006 Runoff Characteristics	9
4.1 CFR at Turah Bridge	10
4.2 BFR near Bonner	11
4.3 CFR above Missoula	12
Section 5. References	14

LIST OF TABLES

Table 1-1	Study reach codes, waterbody and estimated survey length.	3
Table 2-1	Data collection parameters and methods.	4
Table 3-1	Summary of longitudinal profile and cross-section data collected in the study reaches in August 2004, February 2006 and August 2006.	7
Table 3-2	Summary of pebble count and sieve analysis data collected in the study reaches in August 2004, February 2006 and August 2006.	8
Table 3-3	Summary of bank erosion pin and BEHI site data collected in the study reaches.	9
Table 4-1	Summary of annual peak discharges for water years 2005 and 2006 for the CFR at Turah Bridge near Bonner, MT (Station 12334550).	11
Table 4-2	Summary of annual peak discharges for water years 2005 and 2006 for the BFR near Bonner, MT (Station 12340000).	12
Table 4-3	Summary of annual peak discharges for water years 2005 and 2006 for the CFR above Missoula, MT (Station 12340500).	13

LIST OF FIGURES

Figure 1-1	Study Reaches in the Milltown Dam Project Area	2
Figure 4-1	Annual hydrographs for water years 2005 and 2006 for the CFR at Turah Bridge near Bonner, BFR near Bonner and CFR above Missoula (USDGS 2006).	10
Figure 4-2	Annual hydrographs for water years 2005 and 2006 and mean discharge for the period of record for the CFR at Turah Bridge near Bonner, MT (Station 12334550).	11
Figure 4-3	Annual hydrographs for water years 2005 and 2006 and mean daily discharge for the period of record for the BFR near Bonner, MT (Station 12340000).	12
Figure 4-4	Annual hydrographs for water years 2005 and 2006 and mean daily discharge for the period of record for the CFR above Missoula, MT (Station 12340500).	13



LIST OF APPENDICES

Appendix A	CFR NEAR CLINTON, MT
Appendix B	CFR TURAH
Appendix C	CFR 3A
Appendix D	CFR 3B
Appendix E	CFR 3C
Appendix F	CFR BANDMANN
Appendix G	CFR MISSOULA GAGE
Appendix H	BFR BONNER GAGE
Appendix I	BFR OVANDO C
Appendix J	BFR OVANDO B
Appendix K	BFR OVANDO F
Appendix L	MEANDER GEOMETRY
Appendix M	SCOUR CHAINS
Appendix N	BANK EROSION PREDICTION

LIST OF ACRONYMS AND ABBREVIATIONS

Abkf	Bankfull cross section area
BEHI	Bank Erosion Hazard Index
BFR	Blackfoot River
BKF	Bankfull
CFR	Clark Fork River
CH	Channel bottom
Dbkf	Bankfull depth
Dmax	Maximum bankfull depth
Dmbkf	Mean bankfull depth
ft/ft	Gradient - change in elevation divided by change in distance
g	Glide
ML	Meander wavelength
NBS	Near bank stress
p	Pool
P1	User-defined point #1. Note provided if used.
P2	User-defined point #2. Note provided if used.
P3	User-defined point #3. Note provided if used.
P4	User-defined point #4. Note provided if used.
P – P	Pool spacing
P length	Pool length
r	Riffle
RSI	Riffle Stability Index
Rc	Radius of curvature
S bkf	Average bankfull slope
S glide	Glide slope
S pool	Pool slope
S riffle	Riffle slope
S run	Run slope
u	Run
USGS	United States Geological Survey
Wbkf	Bankfull width
WS	Water surface
XS	Cross section

LIST OF SYMBOLS

	Limits of analysis for reported cross section metrics
	Elevation of surveyed bankfull indicators on cross section

Section 1 Introduction

This document summarizes baseline geomorphic data collected prior to removal of Milltown Dam on reaches of the Clark Fork River (CFR) and Blackfoot River (BFR) near Milltown Dam. Data were collected by River Design Group, Inc. and WestWater Consultants, Inc. over a three year period from 2004 to 2006. Data collection and reporting were conducted in accordance with the Phase 3 Scope of Work (State of Montana 2006).

1.1 Objectives

The results of this effort are one of several methods that will be used by the State of Montana (State) to support final channel and floodplain design activities for the Restoration Plan for the CFR and BFR near Milltown Dam. The specific objectives included:

- Conducting detailed reach assessments on the main stem CFR and BFR to characterize existing river and floodplain conditions.
- Completing an air photo temporal analysis on the main stem CFR from Turah Bridge downstream to Milltown Dam.
- Collecting supplemental data on a relatively non impaired river reach displaying similar geomorphic characteristics to the desired future condition of the CFR within the restoration area.
- Compiling the data and results into a summary report to serve as a support document for river and floodplain restoration design tasks.

The data presented herein are displayed in such a manner to allow the reader to view data in a relatively raw format prior to analysis. Subsequent efforts will employ empirical and analytical tools to further the understanding of the reach-scale geomorphic and hydraulic properties associated with the study area. As such, this document does not intend to provide an analysis of hydraulic properties, sediment transport characteristics or flood inundation frequency. These analyses will be presented in separate documents as outlined in the Phase 3 Scope of Work (State of Montana 2006)

For the purposes of this document, the channel-forming discharge is considered to be morphological bankfull (Charlton et al., 1978; Andrews, 1983; Hey and Thorne, 1986). Morphological bankfull indicators were surveyed throughout all reaches and used as a tool to calibrate bankfull discharge and set the boundaries for data included in the reported metrics.

1.2 Study Reaches

The study area encompassed 11 river reaches on the CFR and BFR with varied channel and valley morphologies. Figure 1-1 displays the locations of the study reaches. Table 1-1 summarizes the reach codes and associated lengths.

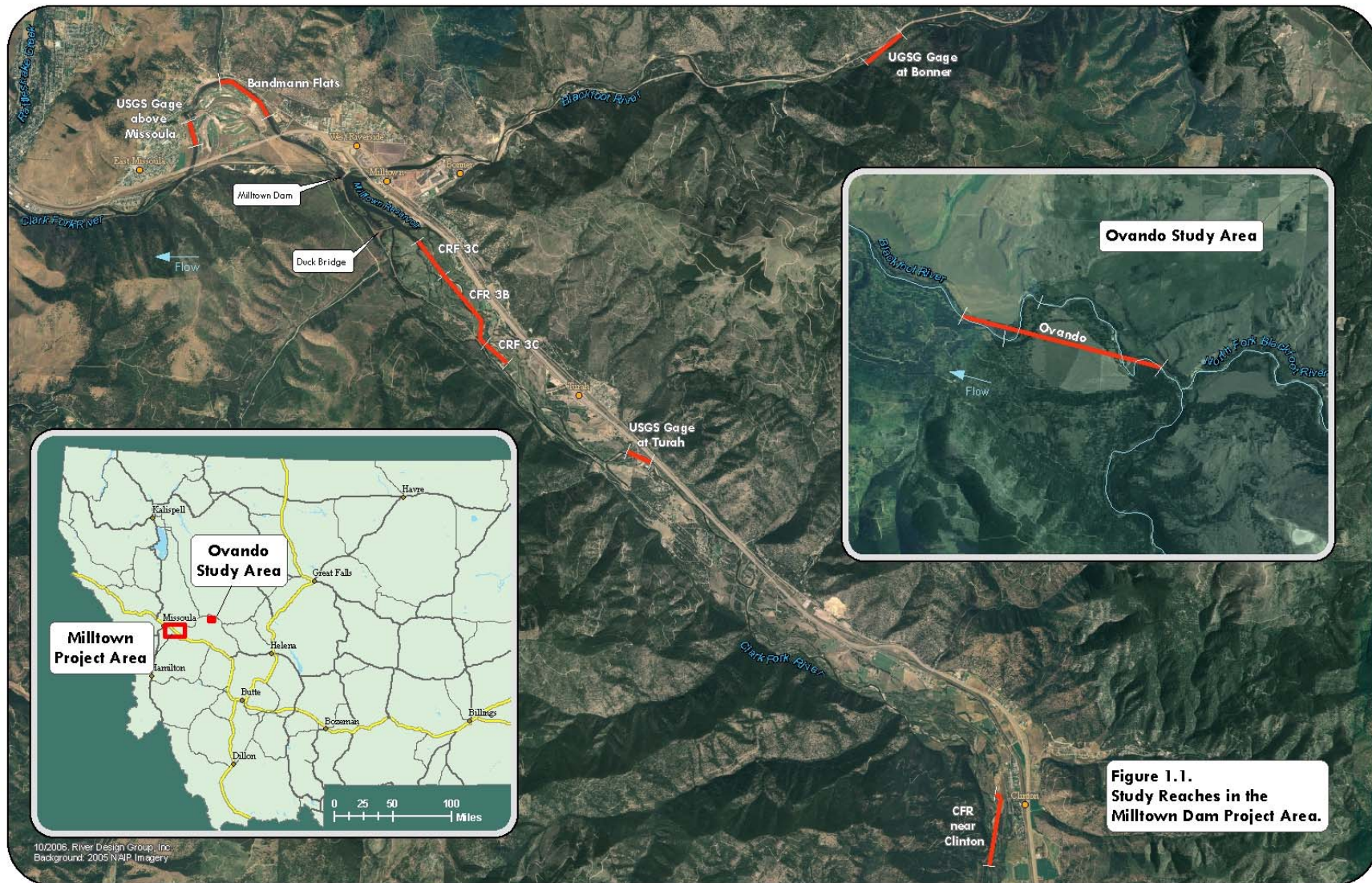


Table 1-1. Study reach codes, waterbody and estimated survey length.

Reach Code	Waterbody	Survey Length ¹ (ft)
CFR near Clinton, MT	CFR	9,400
USGS Gage at Turah	CFR	1,700
CFR 3A	CFR	1,400
CFR 3B	CFR	2,400
CFR 3C	CFR	3,600
Bandmann Flats	CFR	4,200
USGS Gage above Missoula	CFR	1,300
USGS Gage at Bonner	BFR	2,900
Ovando Study Area – C Reach	BFR	8,800
Ovando Study Area – B Reach	BFR	2,650
Ovando Study Area – F Reach	BFR	2,950
Total		41,300 (7.8 miles)

¹ Measured along channel thalweg

1.3 Document Organization

This document is presented as an executive summary followed by data summary appendices. Appendices A through K are dedicated to individual study reaches and are organized as follows:

- Site map
- Reach summary tables
- Longitudinal profile data
- Cross sections data
- Sediment data

Appendices L through N contain reach-scale data encompassing more than one study reach. Appendix K contains meander geometry data and a time trend aerial image analysis for the CFR from Turah Bridge downstream to Duck Bridge. Appendix M contains scour chain data. Appendix N contains a bank erosion prediction analysis for CFR 3A, CFR 3B and CFR 3C. A list of commonly used acronyms and abbreviations is provided in the table of contents

Section 2 Methods

Data collection parameters and methods are summarized in Table 2-1. The reaches were surveyed with a Trimble 3303DR Total Station under the responsible charge of a professional land surveyor licensed to practice in the State of Montana. Photogrammetry was used to complement the CFR surveys and was performed on the greater floodplain and off channel areas within CFR 3. Approximately 80 control points were established from Turah Bridge downstream to Milltown Dam using static Global Positioning System (GPS) observation. Static observations were performed with a

Leica survey grade GPS unit. This step calibrated all control points to satellite GPS coordinates for elevation definition. Field surveys were completed using a four to six person survey and hydrology crew. The CFR Schwartz Creek to Clinton reach was surveyed using a laser level, rod and tape. Cross Section end points were surveyed with a resource-grade GPS and were used to establish distance between cross sections for the profile.

Table 2-1. Data collection parameters and methods.

Parameter	Method
Channel cross-section	Harrelson et al., 1994.
Longitudinal channel profile	Harrelson et al., 1994.
Planform geometry	Langbein and Leopold, 1966; Thorne, 1997.
Substrate Characterization	Wolman, 1954
Riffle Stability Index	Kappeser, 1992
Pavement and sub-pavement particle size distributions	Bunte and Abt, 2001.
Bank erosion prediction	Rosgen (2001a)

2.1 Channel Cross-section and Longitudinal Profile

Representative channel cross-sections were surveyed using standard methods (Harrelson et al., 1994). Cross-sections spanned the active bankfull channel, adjacent floodplain, and low terrace features. Channel units were divided into habitat and channel unit types including pool, riffle, run, and glide features (Bisson et al., 1982). Cross-section distances and measurement frequency varied according to valley bottom and channel width, channel irregularity, and survey objective. Elevation changes (inflection points) in the channel and floodplain were detailed. Surveys detailed morphological features including terraces, floodplains, bankfull indicators, channel bed, channel thalweg, and water surface.

Longitudinal profiles were established in each surveyed reach and included a minimum channel distance equal to 20 times the average bankfull riffle width or two meander wavelengths. The profiles included consistent measurement of left and right channel bankfull indicators, channel thalweg, and water surface elevations at select locations along the profile typically at delineated channel habitat units (e.g. riffles). For stream reaches characterized by multiple active channels, the channel conveying the greatest percentage of the discharge at the time of the survey (near or at baseflow) was selected. Aerial photos were also used to determine the dominant active channel thread during bankfull discharge.

2.2 Planform Geometry

Channel planform geometry was measured in CFR 3A, CFR 3B, CFR 3C and CFR near Clinton. The analysis included radius of curvature, meander wavelength, channel belt width, and sinuosity. Measurements were completed in ArcGIS 9.1 for six photo series including 1937, 1956, 1966, 2000 and 2005 for all reaches except for CFR near Clinton,

which included 1937, 1948, 1966, 1995 and 2005. Results were reported for actual values and dimensionless ratios as a function of bankfull width.

2.3 Substrate Characterization

Channel materials were sampled in the project area to characterize existing bed material characteristics as well as to complement hydraulic and sediment transport modeling.

The Wolman method (Wolman, 1954) was used to characterize the particle size distribution of channel materials. The material sampling locations were modified to ensure various habitat units were sampled proportionally according to their percent representation in the reach. The intermediate axes of the particles were measured (Wolman, 1954; Bunte and Abt, 2001). Samples from habitat units were recorded separately and reported individually and as a composite.

A Riffle Stability Index (RSI) was used to evaluate the particle size percentile of the riffle that is mobile (Kappesser, 1992). This method involved locating a riffle in relatively straight sections of the reach that displayed uniform depth in the cross-section. Particle size distribution on each riffle was determined by the Wolman (1954) method. Sampling points were identified by establishing a sampling grid, with transects extending across the bankfull width over the entire length of the sampled riffle. The intermediate axis of each particle was measured and tallied by size class (Kappesser, 1992). The cumulative percent finer was then plotted against the upper value for each size class to generate a cumulative particle size distribution curve (Kappesser, 1992).

A lateral bar or similar depositional feature was identified in close proximity to the sampled riffle. The intermediate axes of the 30 largest recently deposited particles were measured and the geometric mean calculated and compared with the cumulative particle size distribution of the riffle. The percentile of the cumulative particle size distribution corresponding to the geometric mean of the largest particle sizes on the lateral bar was recorded as the RSI value.

Volumetric sampling was completed to characterize the channel armor layer and subsurface materials (Bunte and Abt, 2001). Surface and subsurface (pavement and sub-pavement) samples were generally collected half way between the thalweg and the bankfull channel margin. The samples were wet-sieved and weighed in the field. Weights were recorded (less tare weight) by size class and a material size-class distribution was plotted.

2.4 Bank Erosion Prediction

A prediction of stream bank erosion rates and sediment loading in CFR 3A, CFR 3B, and CFR 3C was made using the Bank Assessment for Non-point Source Consequences of Sediment (BANCS) method (Rosgen, 2001b). The method utilized two bank erodibility estimation tools including the Bank Erosion Hazard Index (BEHI)

and Near Bank Stress (NBS). The application involves evaluating bank characteristics and flow distribution along the river reach and mapping various risk ratings commensurate with bank and channel changes. A numerical reach score was then developed to rank streambank erosion potential on a scale ranging from very low to extreme.

The BEHI procedure integrates multiple bank integrity parameters which have a direct impact on streambank stability, including the following.

- Ratio of streambank height to bankfull stage.
- Ratio of riparian vegetation rooting depth to streambank height.
- Degree of rooting density.
- Composition of streambank materials.
- Streambank angle.
- Bank material stratigraphy.
- Bank surface protection afforded by woody debris and vegetation.

The BEHI index incorporated these seven variables into a numerical reach score that was used to rank streambank erosion potential on a scale ranging from very low to extreme. After evaluating the core bank integrity parameters, bank material composition factors were considered. Depending upon bank materials, BEHI score were adjusted up or down. Banks comprised of bedrock, boulders and cobble had very low erosion potential. Banks composed of cobble and/or gravel with a high fraction of sand had increased erosion potential. Stratified banks containing layers of unstable material also displayed greater erosion potential. After adjusting the core BEHI score for bank material composition factors, a final BEHI score and rating was derived.

Twelve bank erosion pin sites were installed in CFR 3A, CFR 3B and CFR 3C. Selected sites provided a representative sample of bank conditions throughout the reach. Each site was outfitted with three bank pins positioned in the upper one-third, middle one-third, and lower one-third (toe) of the bank profile. BEHI and NBS assessments were completed for each site. Bank erosion was measured from 2004 through 2006 (post 2005 and 2006 runoffs). The measured bank erosion rate was converted to tons of sediment per year by multiplying the bank height and bank length for banks of similar condition class.

2.5 Data Processing

Total Station survey data was processed and analyzed in RIVERMorph[®] version 4.0 (RIVERMorph LLC, 2005). RIVERMorph[®], a geomorphic stream channel assessment and data storage software package, merged all aspects of the surveys by transcribing the total station data from x, y, and z coordinates to station and elevation formats. The software was used to process data and produce channel reach statistics. Cross-section data and longitudinal profile data were plotted and summary statistics were generated in RIVERMorph[®] and Microsoft Excel.

Section 3 Results

Data summary results are presented in the appending sections to this report. Data is organized by river reach. Meander geometry, scour chain and bank erosion prediction data are presented in separate sections as the data is summarized for multiple reaches. Table 3-1, Table 3-2, and Table 3-3 provides a summary of the data inventoried in each respective reach by sampling event.

Table 3-1. Summary of longitudinal profile and cross-section data collected in the study reaches in August 2004, February 2006 and August 2006.

Survey Date	Longitudinal Profile (ft)	Riffle	Cross-Sections		
			Runs	Pools	Glides
August 2004					
CFR near Clinton	0	0	0	0	0
CFR at Turah Gage	1700	1	0	1	0
CFR A	1400	3	0	0	0
CFR B	2400	7	4	3	5
CFR C	3600	3	0	0	0
CFR at Bandmann	4200	5	2	2	3
CFR at Missoula Gage	1300	1		2	2
BFR near Bonner	2900	2	1	0	2
BFR near Ovando	14400	12	7	6	8
Total	31900	34	14	14	20
February 2006¹					
CFR near Clinton	0	0	0	0	0
CFR at Turah Gage	0	1	0	0	0
CFR 3A	0	0	0	0	0
CFR 3B	0	6	0	0	0
CFR 3C	0	0	0	0	0
CFR at Bandmann	0	2	0	0	0
CFR at Missoula Gage	0	1	0	0	0
BFR near Bonner	0	1	0	0	0
BFR near Ovando	0	0	0	0	0
Total	0	11	0	0	0
August 2006					
CFR near Clinton ²	0	5	4	1	3
CFR at Turah Gage	1700	1	0	1	0
CFR A	1400	3	0	0	0
CFR B	2400	6	4	3	5
CFR C					
CFR at Bandmann					
CFR at Missoula Gage					
BFR near Bonner	2900	1	1	0	2
BFR near Ovando					
Total	8400	16	9	5	10

¹ Collected after spring runoff in 2005 and prior to spring runoff in 2006.

² Collected in November 2006.

Table 3-2. Summary of pebble count and sieve analysis data collected in the study reaches in August 2004, February 2006 and August 2006.

August 2004, February 2006 and August 2006									
Survey Date	Riffle	Run	Pebble Counts				Sieve Analyses		
			Pool	Glide	Comp	RSI	Riffle	Bar	Glide
August 2004									
CFR near Clinton	0	0	0	0	0	0	0	0	0
CFR at Turah Gage	1	0	0	0	0	1	1	0	0
CFR 3A	1	1	0	0	1	1	2	0	0
CFR 3B	3		1		1	1	2	1	1
CFR 3C	3	1	0	0	1	1	0	0	1
CFR at Bandmann	2	0	0	0	0	1	2	0	0
CFR at Missoula									
Gage	1	0	1	1	1	0	1	0	0
BFR near Bonner	1	0	0	1	1	0	1	0	0
BFR near Ovando	9	0	0	2	2	1	4	0	1
Total	21	2	2	4	7	6	13	1	3
February 2006 ¹									
CFR near Clinton	0	0	0	0	0	0	0	0	0
CFR at Turah Gage	1	0	0	0	0	0	0	0	0
CFR 3A	0	0	0	0	0	0	0	0	0
CFR 3B	4	0	0	0	0	0	0	0	0
CFR 3C	0	0	0	0	0	0	0	0	0
CFR at Bandmann	1	0	0	0	0	0	0	0	0
CFR at Missoula									
Gage	1	0	0	0	0	0	0	0	0
BFR near Bonner	1	0	0	0	0	0	0	0	0
BFR near Ovando	0	0	0	0	0	0	0	0	0
Total	8	0	0	0	0	0	0	0	0
August 2006									
CFR near Clinton ²	0	0	0	2	0	2	0	2	0
CFR at Turah Gage	1	0	0	0	0	1	1	0	0
CFR 3A	0	1	0	0	1	1	2	0	0
CFR 3B	4	0	1	0	1	1	2	1	1
CFR 3C	0	0	0	0	0	0	0	0	0
CFR at Bandmann	0	0	0	0	0	0	0	0	0
CFR at Missoula									
Gage	0	0	0	0	0	0	0	0	
BFR near Bonner	1	0	0	1	1	0	1	0	0
BFR near Ovando									
Total	6	1	1	3	3	5	6	3	1

¹ Collected after spring runoff in 2005 and prior to spring runoff in 2006.² Collected in November 2006.

Table 3-3. Summary of bank erosion pin and BEHI site data collected in the study reaches.

Survey Date	Bank Pin Sites	BEHI Sites
August 2004	0	3
CFR A	4	4
CFR B	4	4
CFR C	4	4
CFR at Bandmann	0	4
CFR at Missoula Gage	0	2
BFR near Bonner	0	4
BFR near Ovando	0	10
Total	12	35
February 2006¹		
CFR at Turah Gage	0	0
CFR A	4	0
CFR B	4	
CFR C	4	0
CFR at Bandmann	0	0
CFR at Missoula Gage	0	0
BFR near Bonner	0	0
BFR near Ovando	0	0
Total	12	0
August 2006		
CFR at Turah Gage	0	3
CFR A	4	4
CFR B	4	4
CFR C	4	4
CFR at Bandmann		4
CFR at Missoula Gage		
BFR near Bonner		4
BFR near Ovando		
Total	8	15

¹ Collected after spring runoff in 2005 and prior to spring runoff in 2006.

Section 4 Water Years 2005 and 2006 Runoff Characteristics

Streamflow characteristics of the CFR and BFR were evaluated for water years 2005 and 2006 (Figure 4-1). The objective was to determine the annual peaks, peak flow durations and estimated return periods for the observed mean daily peak discharges in 2005 and 2006. An updated flood frequency analysis was computed for the CFR above Missoula (Station 12340500), CFR at Turah Bridge near Bonner (Station 12334550), and the BFR near Bonner (Station 12340000) using a Log Pearson III analysis in

accordance with Bulletin 17B Guidelines for Determining Flood Flow Frequency (U.S. Geological Survey, 1982). Figure 4-1 presents annual hydrographs for water years 2005 and 2006. Field sampling periods are noted.

The annual hydrographs of both rivers generally exhibited several peak flow events that occurred between May and June of both water years. The annual peaks were largely driven by snowmelt, rain-on-snow, and rain-on-snowmelt events.

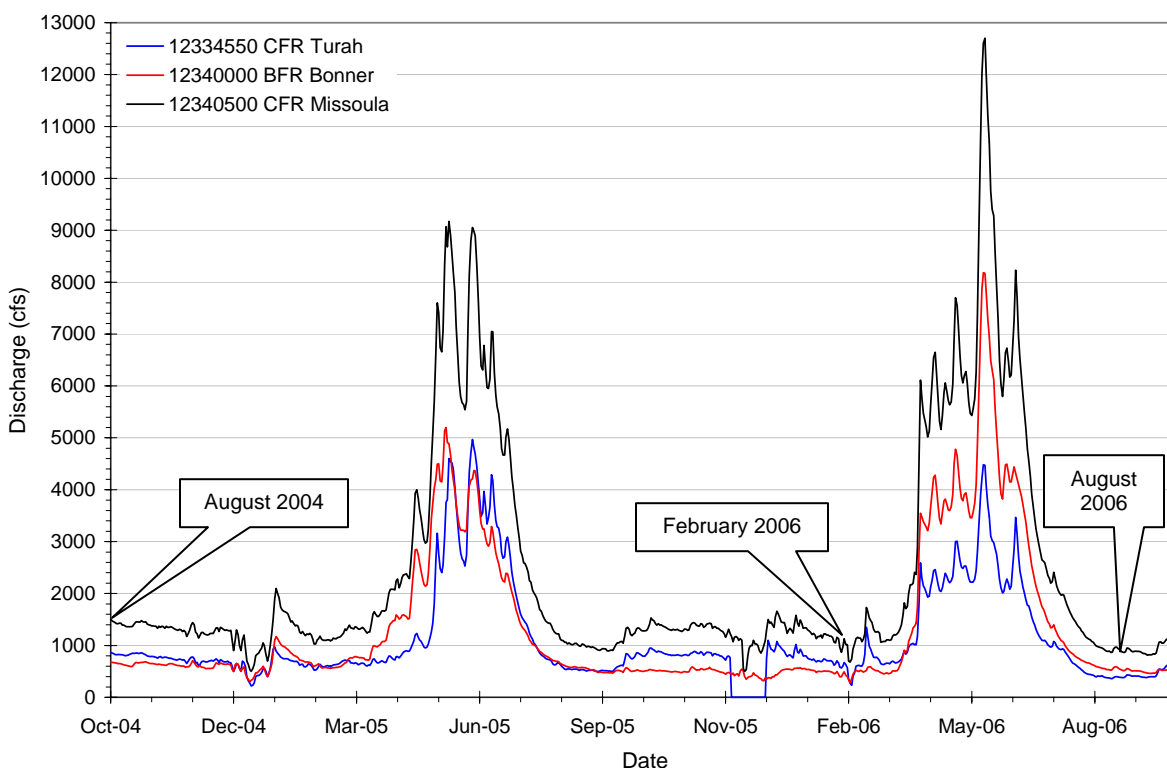


Figure 4-1. Annual hydrographs for water years 2005 and 2006 for the CFR at Turah Bridge near Bonner, BFR near Bonner and CFR above Missoula (USGS 2006).

4.1 CFR at Turah Bridge

The CFR at Turah Bridge experienced several floods in excess of bankfull discharge in water years 2005 and 2006 (Figure 4-2). The events occurred in late May and early June in response to rain-on-snowmelt conditions. In water year 2005, two events with estimated return intervals of 1.9 and 2.2 years exceeded bankfull discharge for a total of 31 days. The observed mean daily peak flows were 4600 cfs and 4970 cfs, respectively. The maximum recorded mean daily peak flow in water year 2006 was 4480 cfs, corresponding to a 1.9 year return interval flood. Streamflow exceeded bankfull discharge for approximately 10 days in water year 2006 (Table 4-1).

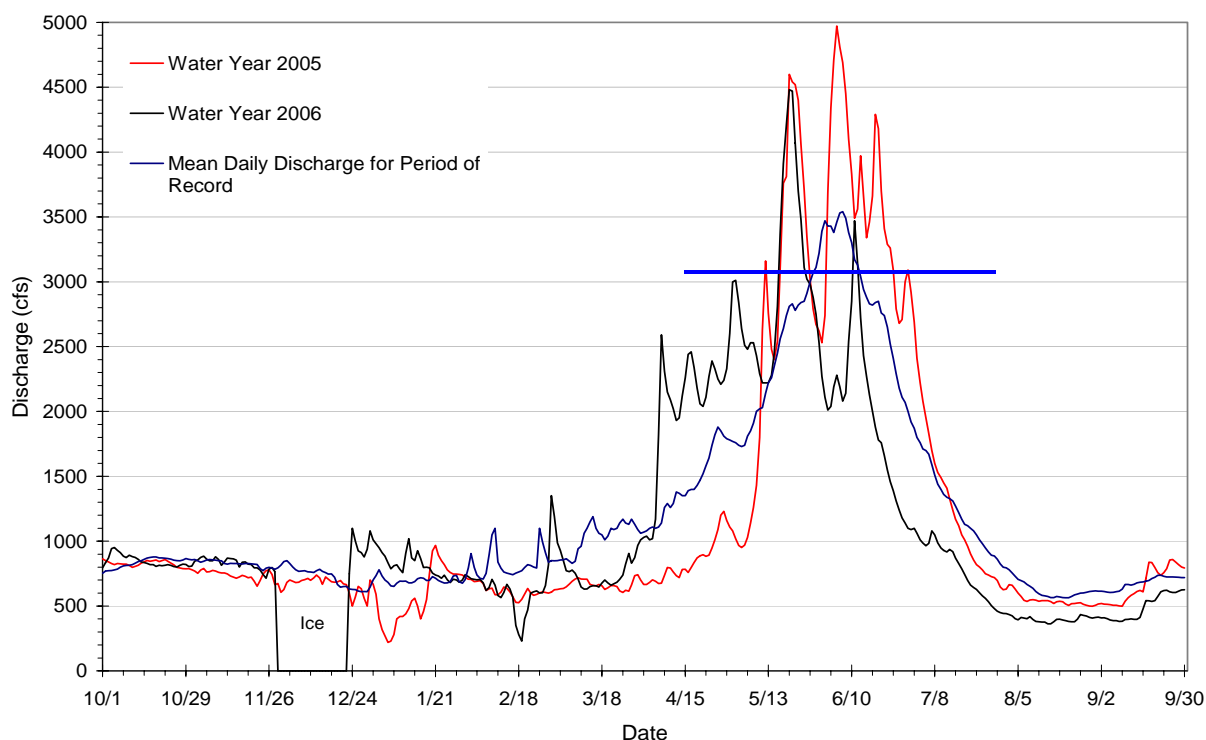


Figure 4-2. Annual hydrographs for water years 2005 and 2006 and mean daily discharge for the period of record for the CFR at Turah Bridge near Bonner, MT (Station 12334550). The blue line denotes the estimated bankfull discharge.

Table 4-1. Summary of annual peak discharges for water years 2005 and 2006 for the CFR at Turah Bridge near Bonner, MT (Station 12334550).

Water Year	Event	Date	Mean Daily Peak Discharge (cfs)	Return Interval (yrs)	Duration Above Bankfull (days) ¹
2005	1	May 12	3160	1.4	0
	2	May 20	4600	1.9	10
	3	June 5	4970	2.2	21
2006	1	May 20	4480	1.9	8
	2	June 11	3470	1.5	2

¹ CFR Turah – 3,200 cfs; CFR Missoula – 10,400 cfs; BFR Bonner – 6,200 cfs

4.2 BFR near Bonner

The highest recorded mean daily discharge in 2005 was 5200 cfs, with a return interval of 1.2 years. In 2006, the BFR peaked at 8170 cfs (return interval = 1.8) with average daily flows exceeding bankfull discharge for eight days. Figure 4-3 includes annual hydrographs for water years 2005 and 2006 and mean daily discharge for the period of record. Peak flow data is summarized in Table 4-2.

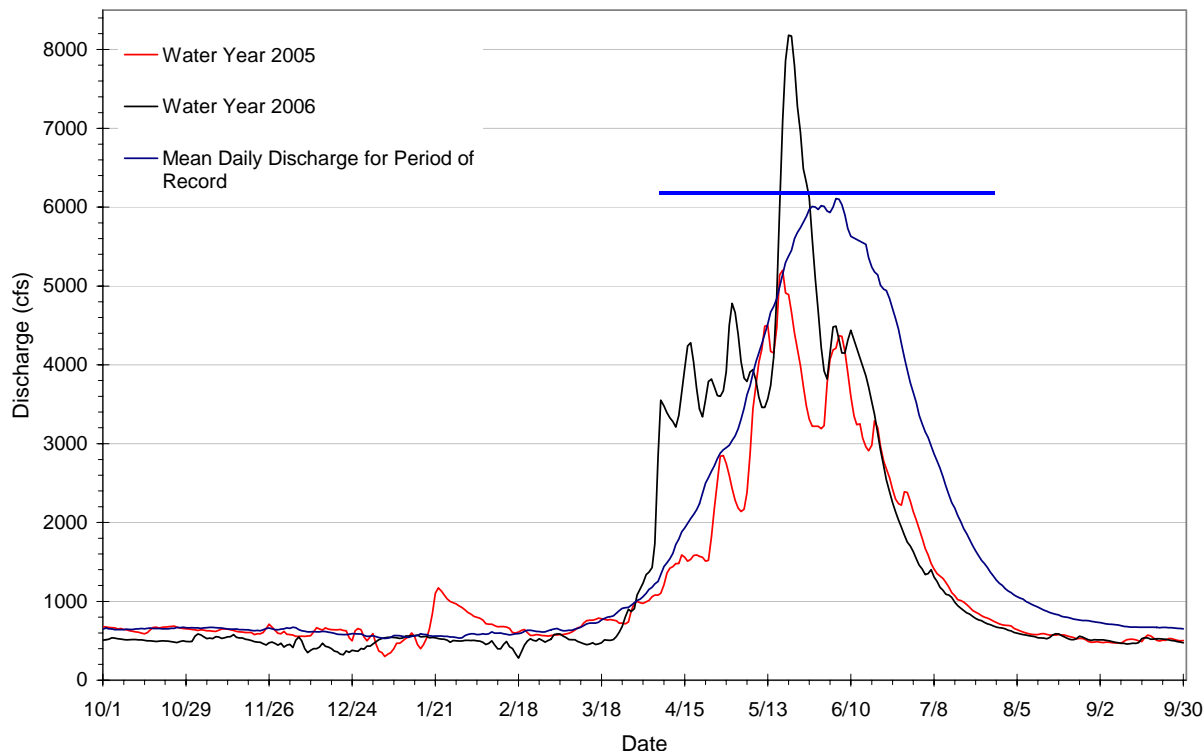


Figure 4-3. Annual hydrographs for water years 2005 and 2006 and mean daily discharge for the period of record for the BFR near Bonner, MT (Station 12340000). The blue line denotes the estimated bankfull discharge.

Table 4-2 summarizes annual peak discharges for water years 2005 and 2006.

Table 4-2. Summary of annual peak discharges for water years 2005 and 2006 for the BFR near Bonner, MT (Station 12340000).

Water Year	Event	Date	Mean Daily Peak Discharge (cfs)	Return Interval (yrs)	Duration Above Bankfull (days) ¹
2005	1	May 6	4320	1.1	0
	2	May 18	5200	1.2	0
2006	1	May 1	4780	1.1	0
	2	May 21	8170	1.8	8

¹ CFR Turah – 3,200 cfs; CFR Missoula – 10,400 cfs; BFR Bonner – 6,200 cfs

4.3 CFR above Missoula

The highest recorded mean daily discharge in 2005 was 9170 cfs, with a return interval of 1.3 years. In 2006, the CFR peaked at 12,700 cfs (return interval 1.7) with average daily flows exceeding bankfull discharge for seven days. Figure 4-4 includes annual

hydrographs for water years 2005 and 2006 and mean daily discharge for the period of record. Peak flow data is summarized in Table 4-2.

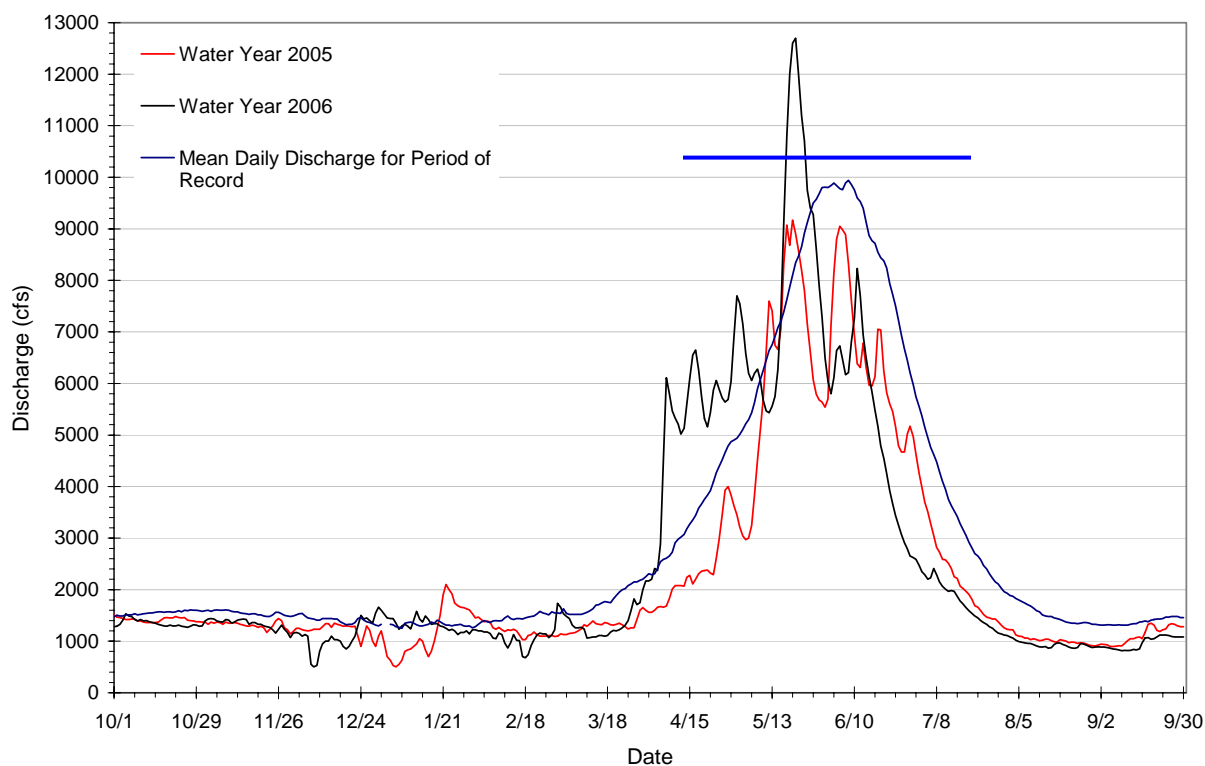


Figure 4-4. Annual hydrographs for water years 2005 and 2006 and mean daily discharge for the period of record for the CFR above Missoula, MT (Station 12340500). The blue line denotes the estimated bankfull discharge.

Table 4-3. Summary of annual peak discharges for water years 2005 and 2006 for the CFR above Missoula, MT (Station 12340500).

Water Year	Event	Date	Instantaneous Peak Discharge (cfs)	Return Interval (yrs)	Duration Above Bankfull (days) ¹
2005	1	May 20	9170	1.3	0
	2	June 6	8980	1.2	0
2006	1	May 1	7700	1.2	0
	2	May 21	12700	1.7	7

¹ CFR Turah – 3,200 cfs; CFR Missoula – 10,400 cfs; BFR Bonner – 6,200 cfs

Section 5 References

Andrews, E.D. 1983. Entrainment of gravel from naturally sorted riverbed material. Geological Society of America Bulletin 94: 1225-1231.

Bisson, P.A., J.L. Nielsen, R.A. Palmason, and L.E. Grove. 1982. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low streamflow. In N.B. Armantrout [ed.] Acquisition and Utilization of Aquatic Habitat Inventory Information: Proceedings of the Symposium. [Portland, OR, October 1981].

Bunte, K., and S.R. Abt. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel- and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. USDA Forest Service, Rocky Mountain Research Station, Gen. Tech. Rep. RMRS-GTR-74, Fort Collins, CO, 428 p.

Charlton, F.G., P.M. Brown, and R.W. Benson, 1978. The Hydraulic Geometry of Some Gravel Rivers in Britain. Hydraulics Research Station, Wallingford, Oxfordshire, United Kingdom, Report IT 180.

Harrelson, C.C., Rawlins, C.L., and Potyondy, J.P. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. Gen Tech Rep RM-245. Fort Collins, CO: U.S. Dept of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Hey, R. D., and Thorne, C. R. 1986. Stable channels with mobile gravel beds. Journal of Hydraulic Engineering, American Society of Civil Engineers, 112(8): 671-689.

Kappesser, G. 1992. Riffle armor stability index. Unpublished report, Idaho Panhandle National Forest, Coeur d'Alene, Idaho. 7 pages.

Langbein, W.B., and L.B. Leopold. 1966. River meanders - theory of minimum variance. Geol. Surv. Prof. Papers, United States Printing Office, Washington, Report No: 422-H, 1-15.

RIVERMorph LLC. 2005. Stream Restoration Software. Louisville, Kentucky 40223-2177.

Rosgen, D.L. 2001a. A Practical Method of Computing Streambank Erosion Rate. Proceedings of the Seventh Federal Interagency Sedimentation Conference, Vol. 2, pp. II - 9-15, March 25-29, 2001, Reno, NV.

Rosgen, D.L. 2001b. A Stream Channel Stability Assessment Methodology. Proceedings of the Seventh Federal Interagency Sedimentation Conference, Vol. 2, pp. II - 18-26, March 25-29, 2001, Reno, NV.

State of Montana. 2006. Phase 3 Scope of Work for the Final Restoration Plan for the Clark Fork River and Blackfoot River near Milltown Dam. State of Montana Department of Justice Natural Resource Damage Program, Helena, Montana.

Thorne, C.R., R.D. Hey, and M.D. Newson (Editors). 1997. Applied Fluvial Geomorphology for River Engineering and Management. J. Wiley & Sons, Chichester, p

U.S. Geological Survey. 1982. Guidelines for Determining Flood Flow Frequency. U.S. Geological Survey. Reston, VA.

Wolman, M.G. 1954. A method of sampling coarse river-bed gravel. Transactions of American Geophysical Union 35: 951-956.

Appendix A

CFR near Clinton



REACH: CFR AT CLINTON**Channel Cross-section Dimensions**

Reach	Cross-section Metric	Riffle 2006		
		Min	Mean	Max
CFR Clinton	Bankfull Area (ft ²)	551.0	671.1	777.0
	Width/Depth Ratio	30.7	40.9	48.9
	Mean Depth (ft)	2.8	3.7	4.8
	Max Depth (ft)	4.3	5.7	7.7
	Width (ft)	156.0	187.9	254.0

Reach	Cross-section Metric	Run 2006		
		Min	Mean	Max
CFR Clinton	Bankfull Area (ft ²)	617.0	784.0	951.0
	Width/Depth Ratio	25.8	44.2	62.5
	Mean Depth (ft)	3.1	3.4	3.6
	Max Depth (ft)	6.0	6.1	6.1
	Width (ft)	196.0	231.0	266.0

Reach	Cross-section Metric	Pool 2006		
		Min	Mean	Max
CFR Clinton	Bankfull Area (ft ²)	601.0	676.0	751.0
	Width/Depth Ratio	33.3	34.7	36.0
	Mean Depth (ft)	3.5	3.8	4.1
	Max Depth (ft)	6.0	7.7	9.4
	Width (ft)	147.0	178.0	209.0

Reach	Cross-section Metric	Glide 2006		
		Min	Mean	Max
CFR Clinton	Bankfull Area (ft ²)	566.0	581.0	596.0
	Width/Depth Ratio	42.9	44.9	46.8
	Mean Depth (ft)	2.3	3.0	3.7
	Max Depth (ft)	3.7	4.6	5.5
	Width (ft)	160.0	188.0	216.0

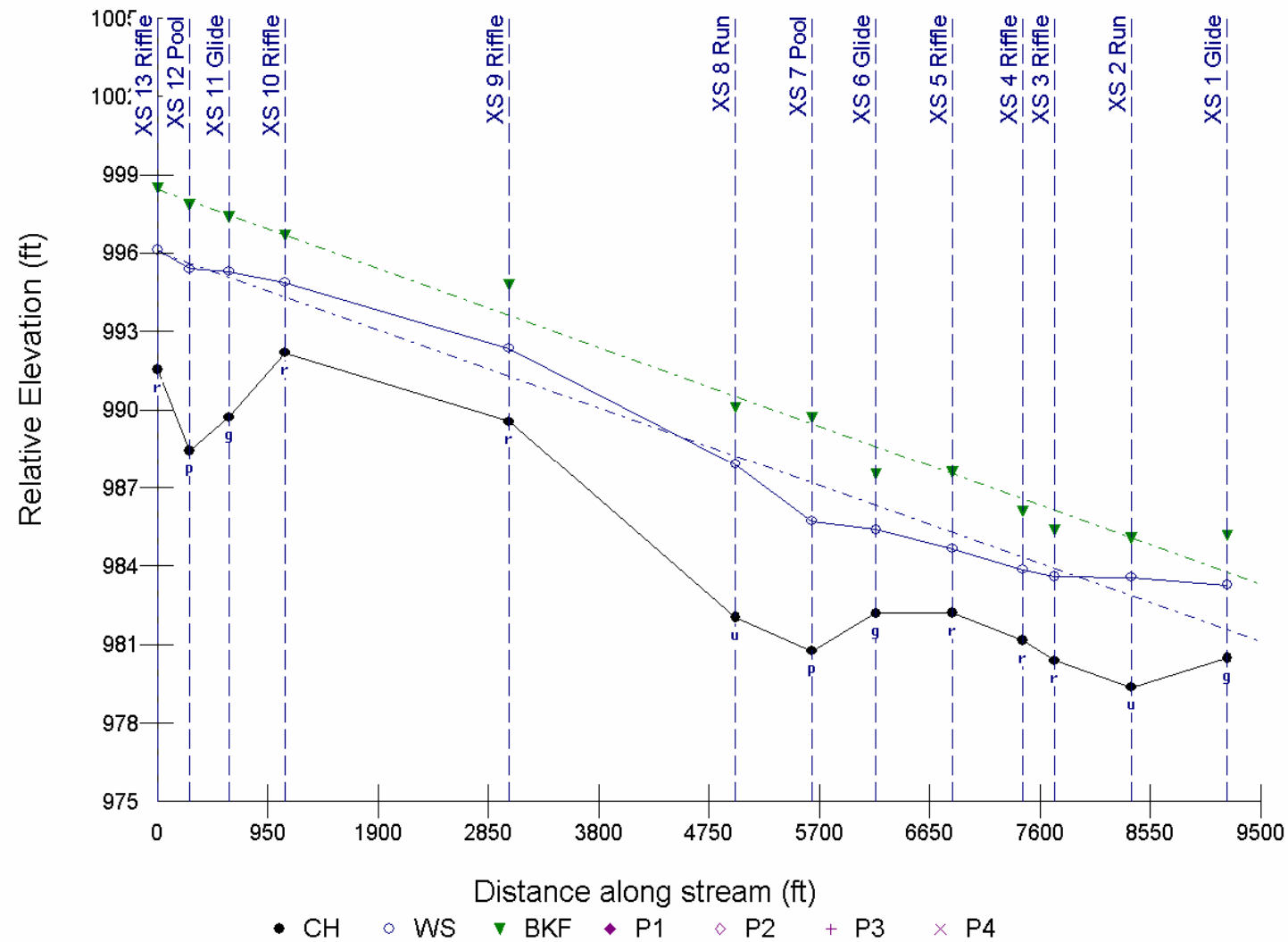
Channel Planform Dimensions and Dimensionless Ratios

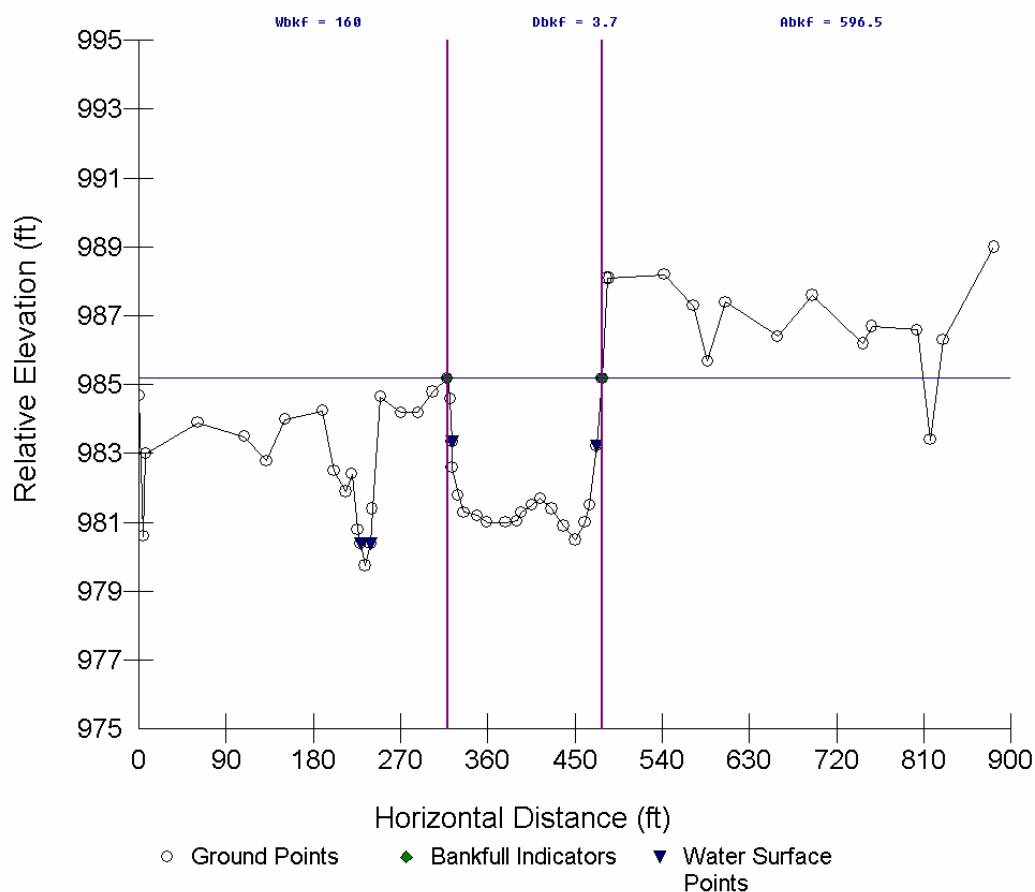
Year	Planform Metric			
	Meander Length (ft)	Radius of Curvature (ft)	Belt Width (ft)	Sinuosity (ft/ft)
1937	1795	737	584	n/a
1948	2329	722	684	1.11
1966	2355	586	835	1.18
1995	2717	811	939	1.14
2005	2778	755	942	1.22

Year	Planform Dimensionless Ratios [^]			
	Meander Length / Wbkf	Radius of Curvature / Wbkf	Belt Width / Wbkf	Sinuosity (ft/ft)
1937	10.7	4.4	3.5	n/a
1948	13.9	4.3	4.1	1.11
1966	14.0	3.5	5.0	1.18
1995	16.2	4.8	5.6	1.14
2005	16.5	4.5	5.6	1.22

[^]: An average riffle width of 168 ft (average of cross-sections 3,4, and 5) was used to develop the dimensionless ratios.

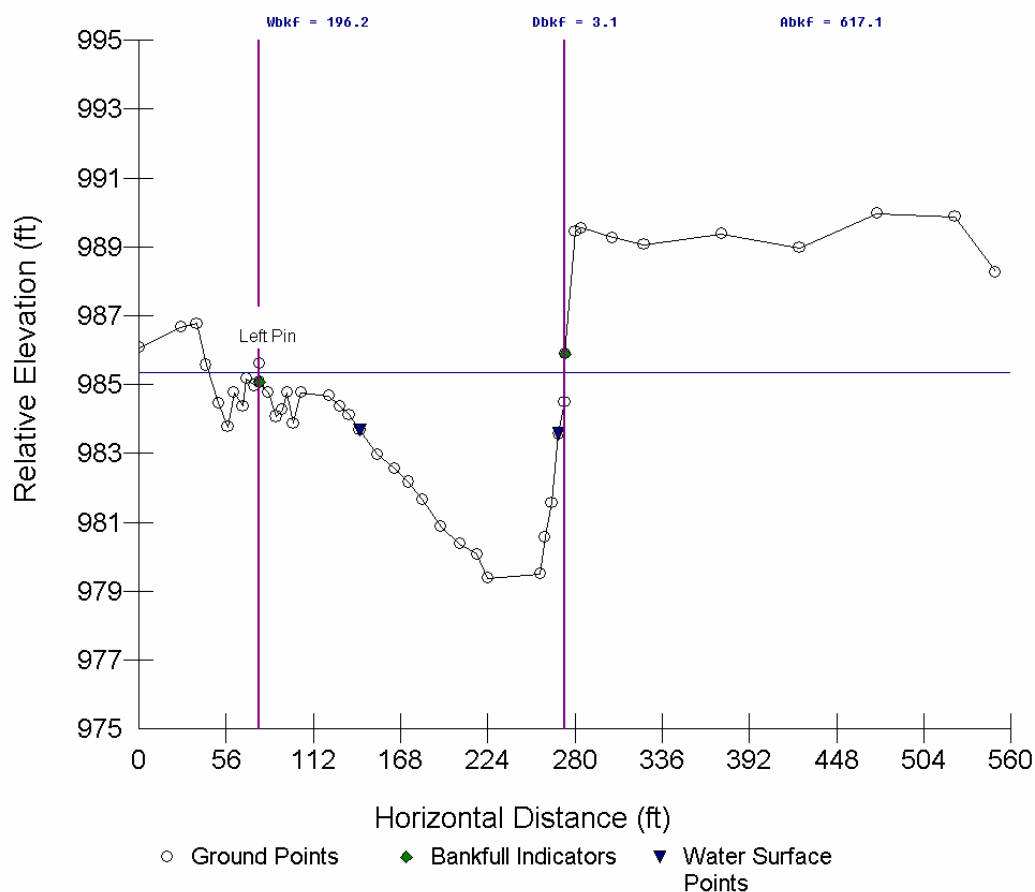
CFR near Clinton 2006



Reach: **CFR near Clinton**Cross-Section: **1**Channel Unit: **Glide**

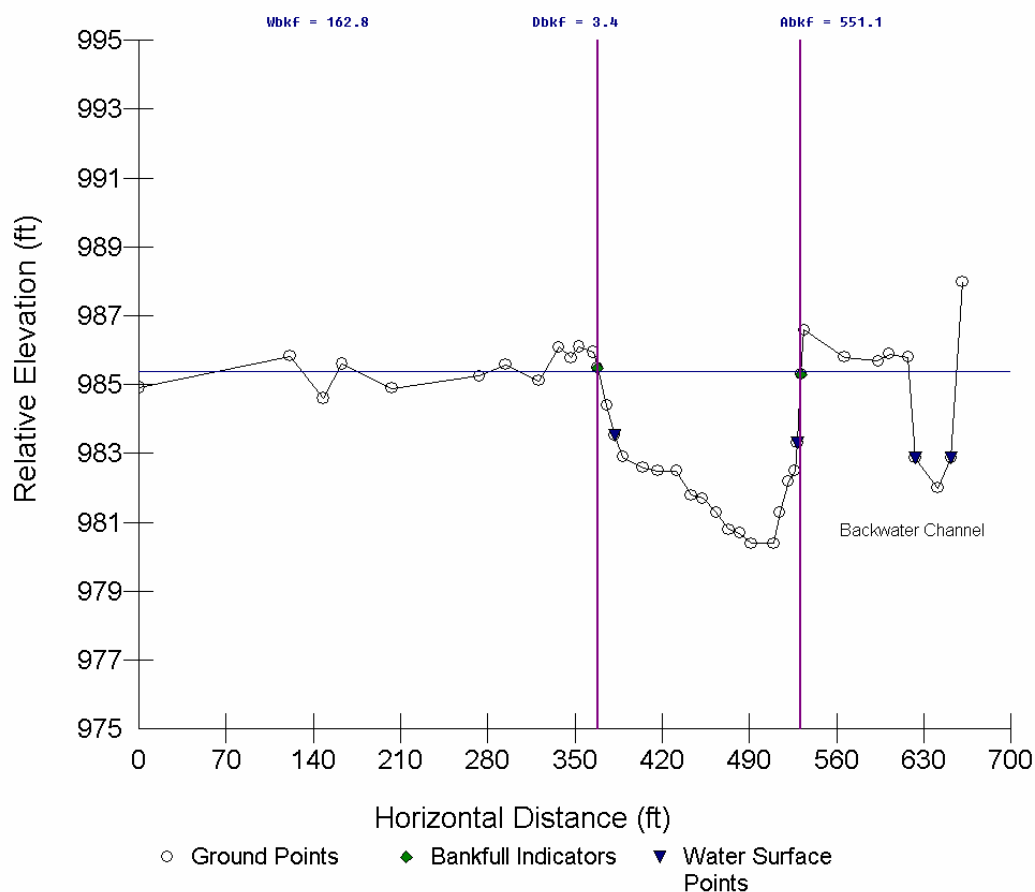
Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 1 (Glide)

	2006
Bankfull Area (ft ²)	596
Width/Depth Ratio	42.9
Bankfull Width (ft)	160
Mean Depth (ft)	3.7

Reach: **CFR near Clinton**Cross-Section: **2**Channel Unit: **Run**

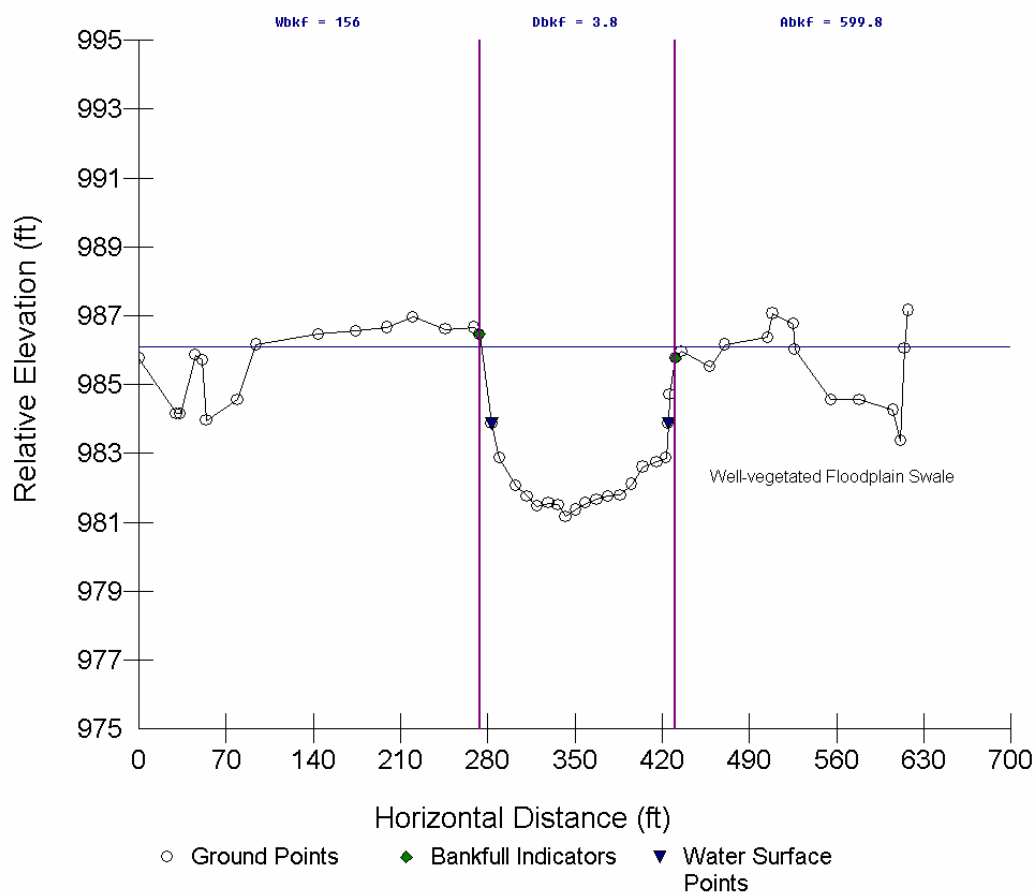
Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 2 (Run)

	2006
Bankfull Area (ft ²)	617
Width/Depth Ratio	62.5
Bankfull Width (ft)	196
Mean Depth (ft)	3.1

Reach: **CFR near Clinton**Cross-Section: **3**Channel Unit: **Riffle**

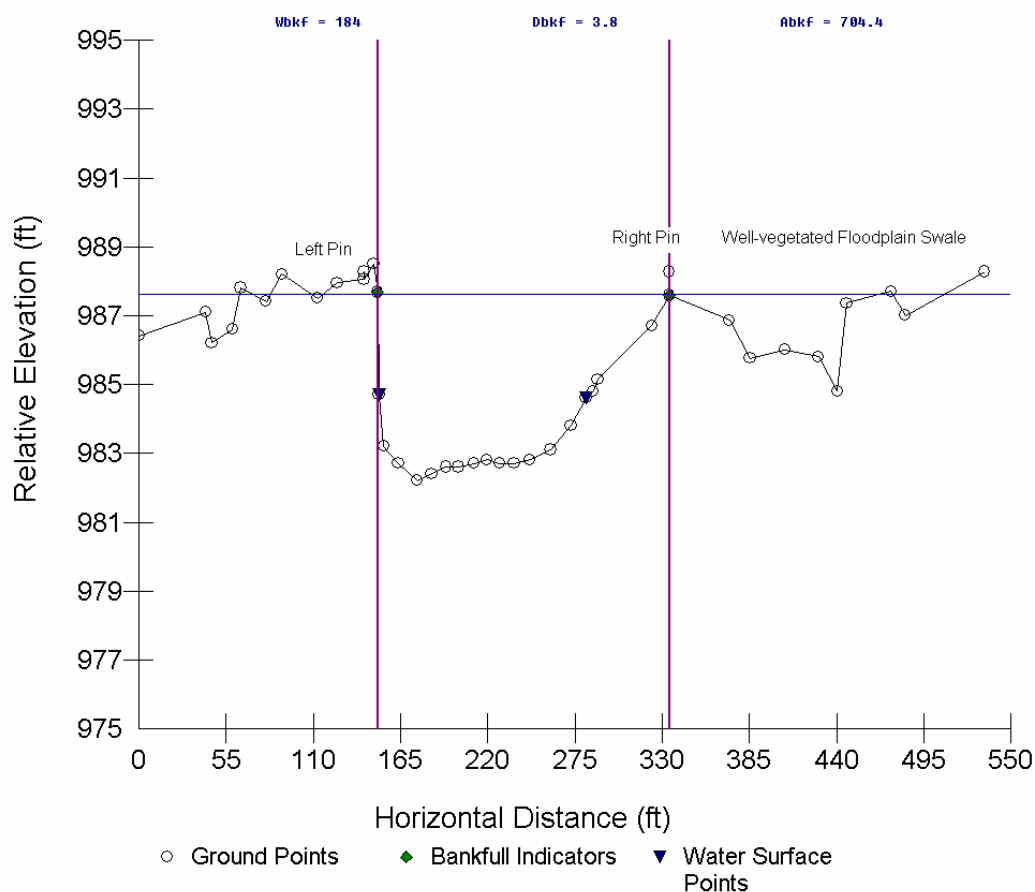
Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 3 (Riffle)

	2006
Bankfull Area (ft ²)	551
Width/Depth Ratio	48.0
Bankfull Width (ft)	163
Mean Depth (ft)	3.4

Reach: **CFR near Clinton**Cross-Section: **4**Channel Unit: **Riffle**

Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 4 (Riffle)

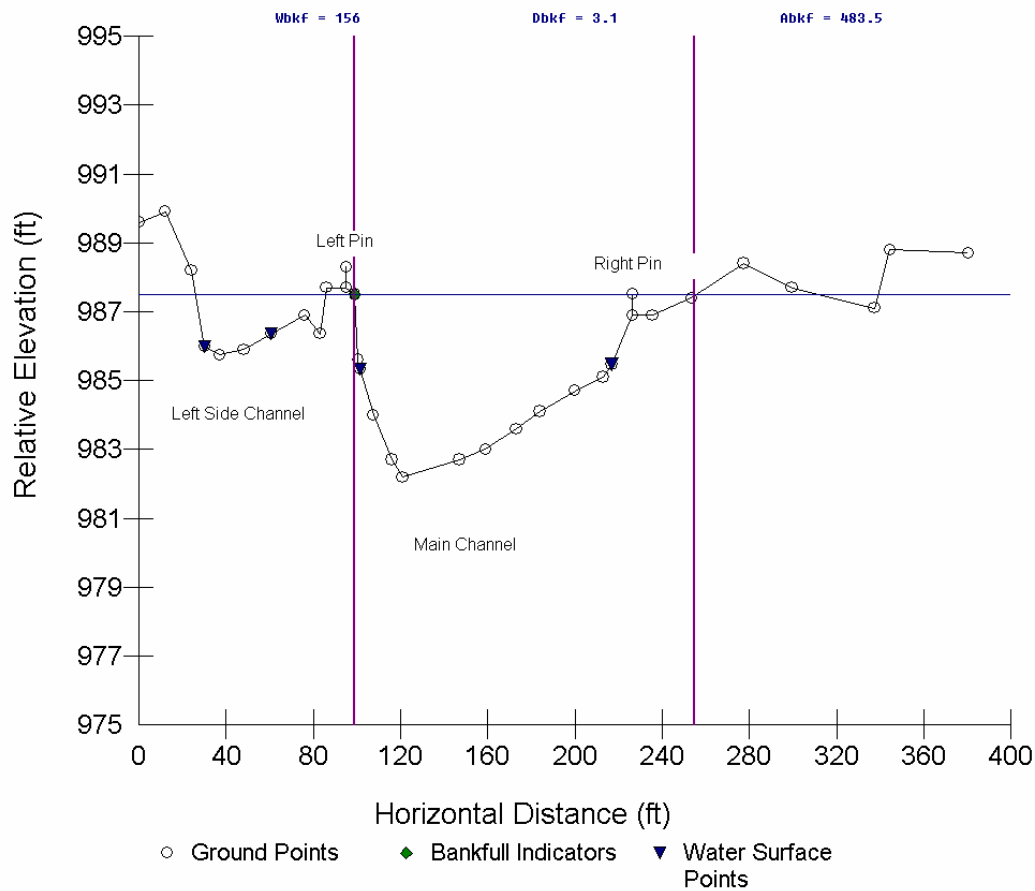
	2006
Bankfull Area (ft ²)	600
Width/Depth Ratio	40.5
Bankfull Width (ft)	156
Mean Depth (ft)	3.9

Reach: **CFR near Clinton**Cross-Section: **5**Channel Unit: **Riffle***

Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 5 (Riffle)

	2006
Bankfull Area (ft ²)	704
Width/Depth Ratio	48.0
Bankfull Width (ft)	184
Mean Depth (ft)	3.8

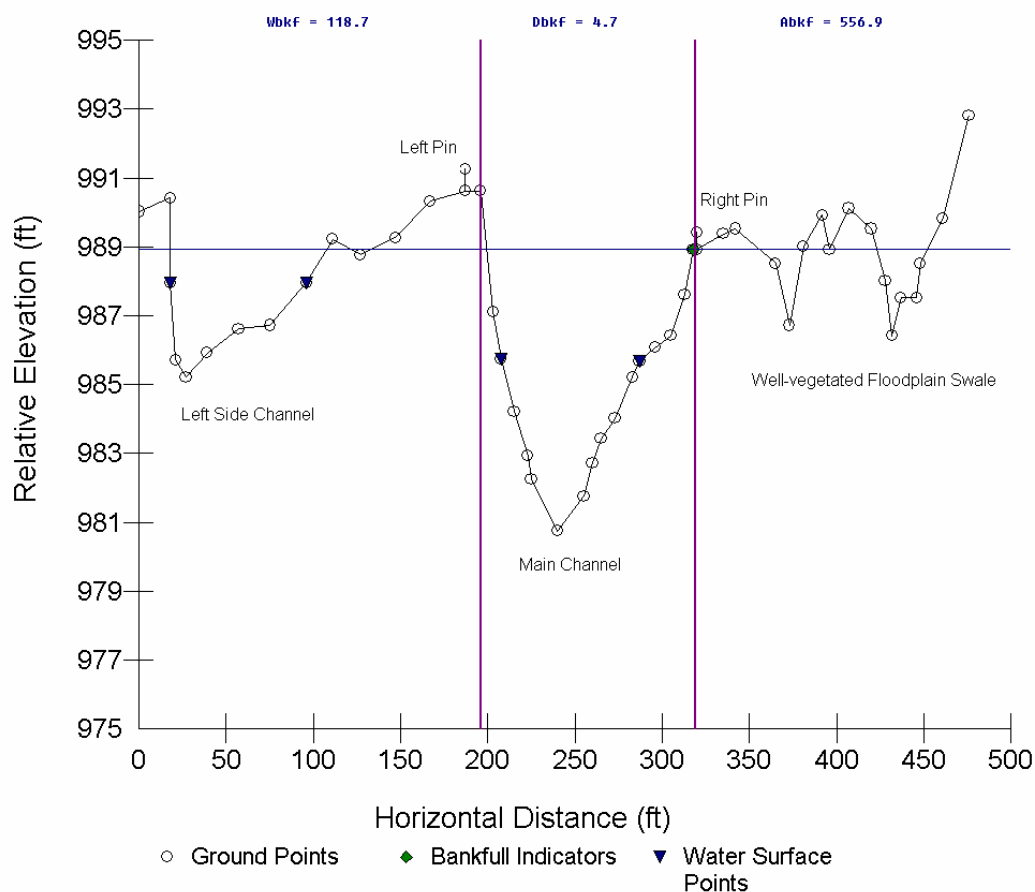
*Riffle cross-section occurs at apex of meander.

Reach: **CFR near Clinton**Cross-Section: **6**Channel Unit: **Glide**

Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 6 (Glide)

	Main Channel	Left Side Channel	Cumulative ¹
Bankfull Area (ft ²)	483	83.3	566
Width/Depth Ratio	50.3	43.3	46.8
Bankfull Width (ft)	156	60.2	216
Mean Depth (ft)	3.1	1.4	2.3

¹Cumulative values for area and width are sums while w/d ratios and depths are means.

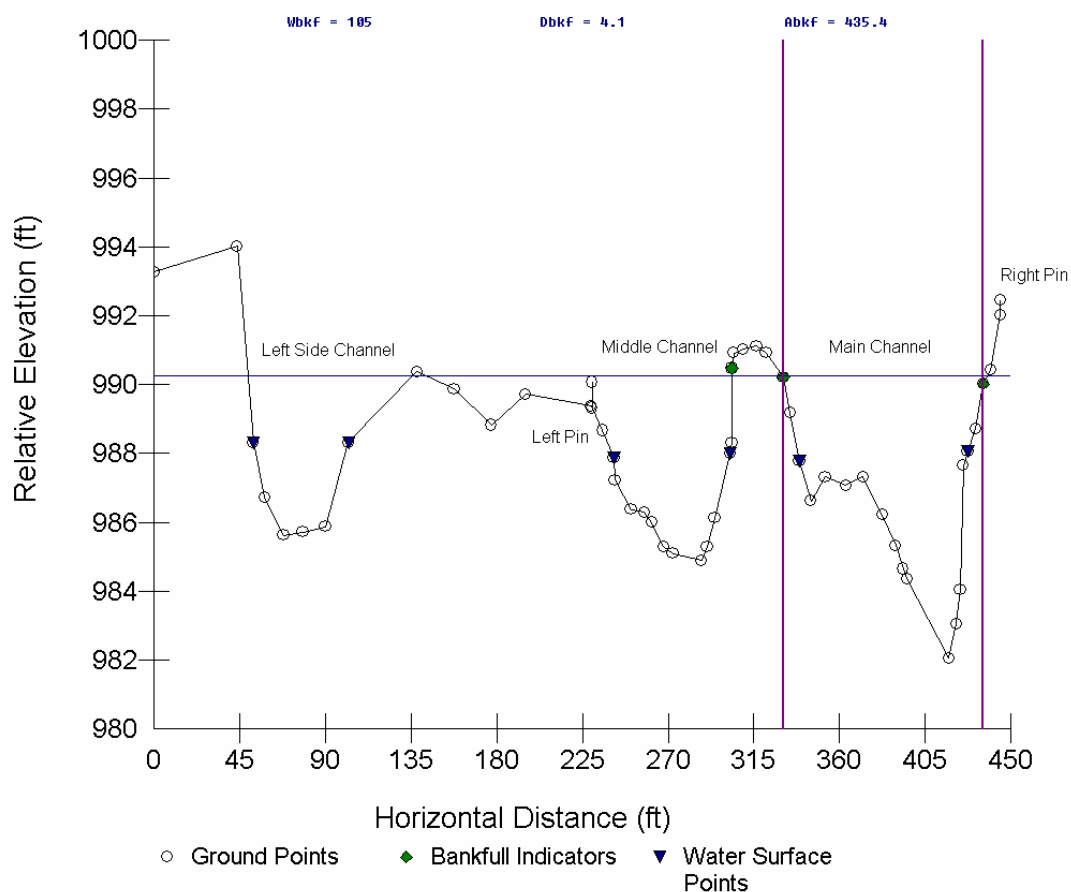
Reach: **CFR near Clinton**Cross-Section: **7**Channel Unit: **Pool**

Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 7 (Pool)

	Main Channel	Left Side Channel ¹	Cumulative ²
Bankfull Area (ft ²)	557	194	751
Width/Depth Ratio	25.3	41.2	33.3
Bankfull Width (ft)	119	89.5	209
Mean Depth (ft)	4.7	2.2	3.5

¹Left side channel water surface elevation is beaver influenced.

²Cumulative values for area and width are sums while w/d ratios and depths are means.

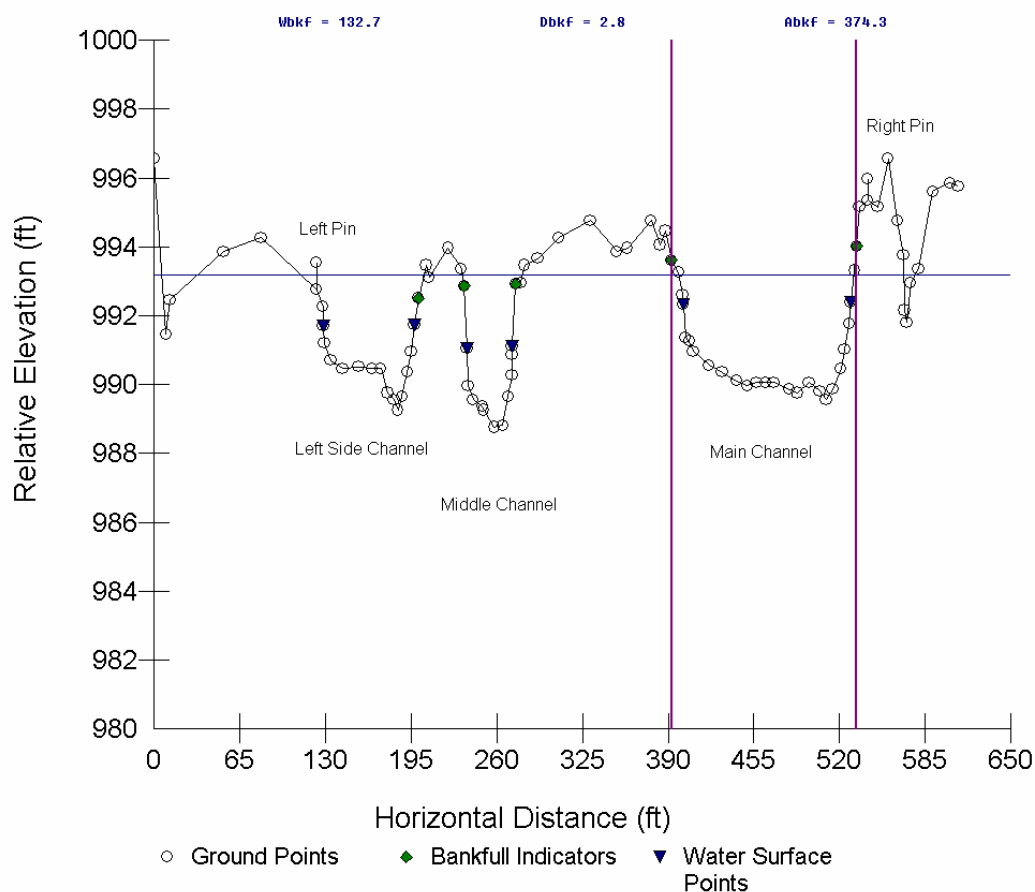
Reach: **CFR near Clinton**Cross-Section: **8**Channel Unit: **Run**

Channel Cross-Section Summary Data (2006)

CFR near Clinton, Cross-Section 8 (Run)

	Main Channel	Middle Channel	Left Side Channel	Cumulative ¹
Bankfull Area (ft ²)	435	287	229	951
Width/Depth Ratio	25.3	19.4	32.8	25.8
Bankfull Width (ft)	105	74.5	86.6	266.1
Mean Depth (ft)	4.2	3.9	2.6	3.6
Max Depth (ft)	8.2	5.4	4.6	6.1

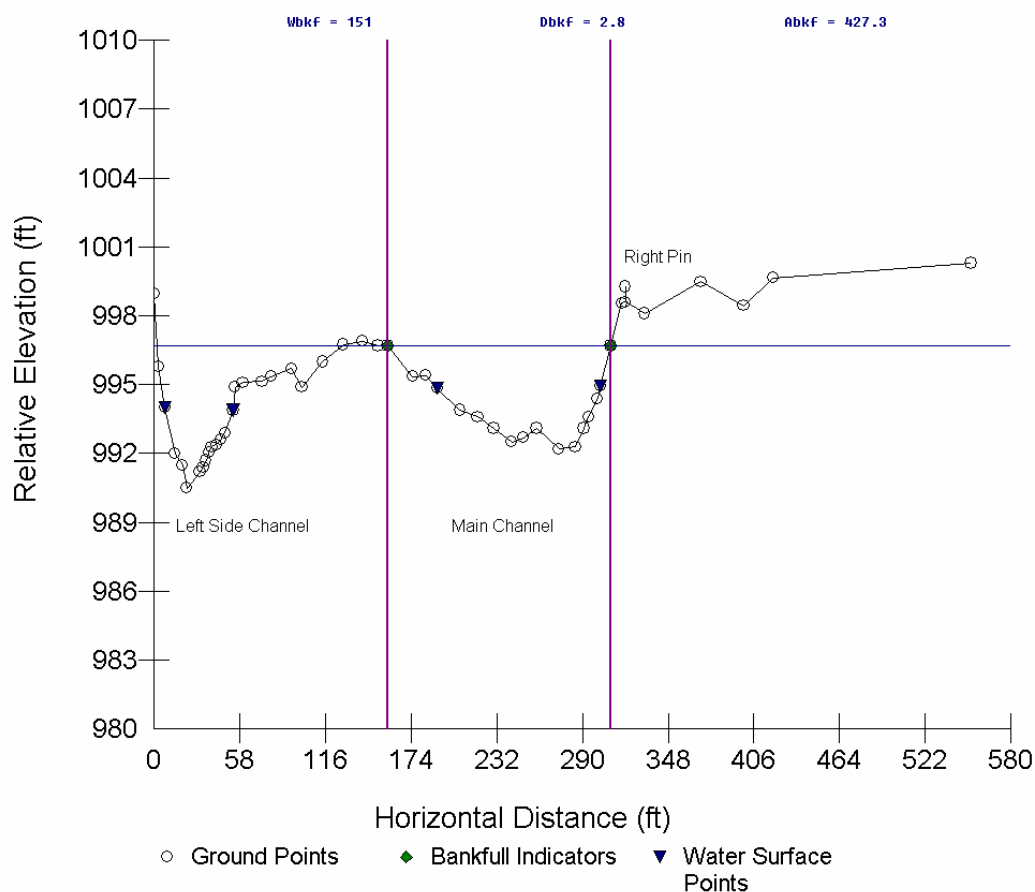
¹Cumulative values for area and width are sums while w/d ratios and depths are means.

Reach: **CFR near Clinton**Cross-Section: **9**Channel Unit: **Riffle**

Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 9 (Riffle)

	Main Channel	Middle Channel	Left Side Channel	Cumulative ¹
Bankfull Area (ft ²)	461	127	150	738
Width/Depth Ratio	42.6	11.8	37.7	30.7
Bankfull Width (ft)	140	38.8	75	254
Mean Depth (ft)	3.3	3.3	2.0	2.9
Max Depth (ft)	5.1	4.1	3.8	4.3

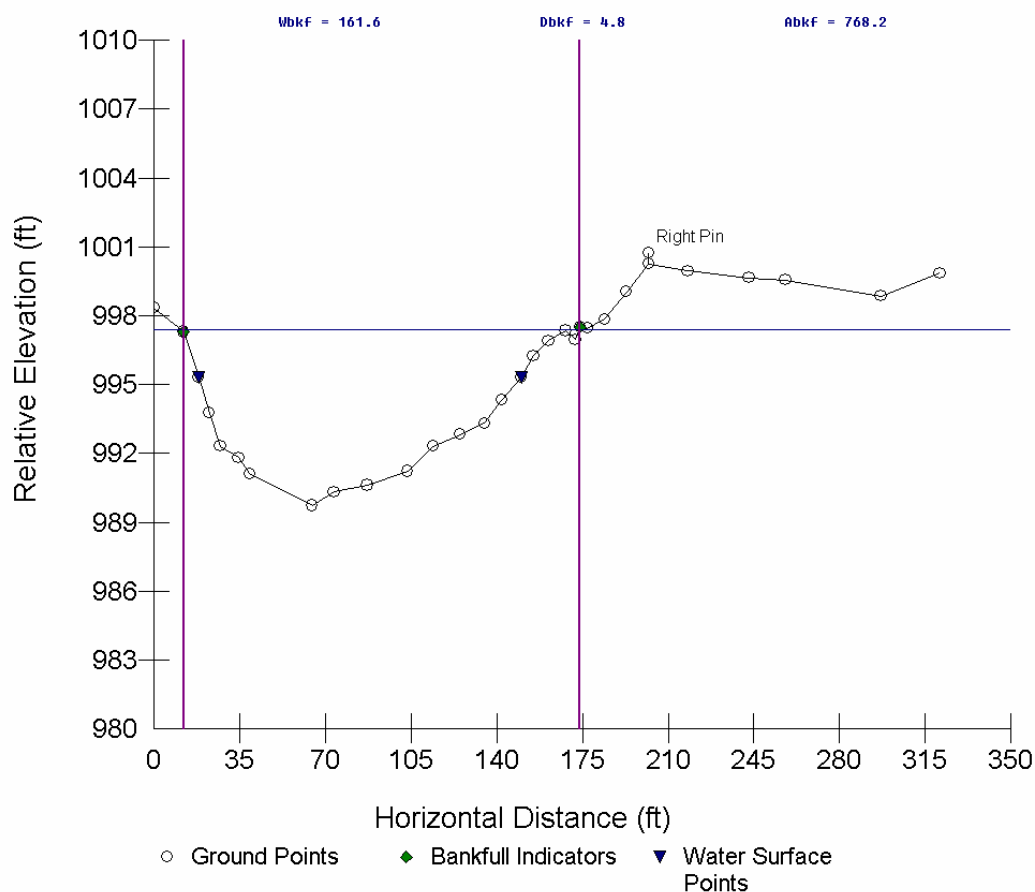
¹Cumulative values for area and width are sums while w/d ratio and depths are means.

Reach: **CFR near Clinton**Cross-Section: **10**Channel Unit: **Riffle**

Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 10 (Riffle)

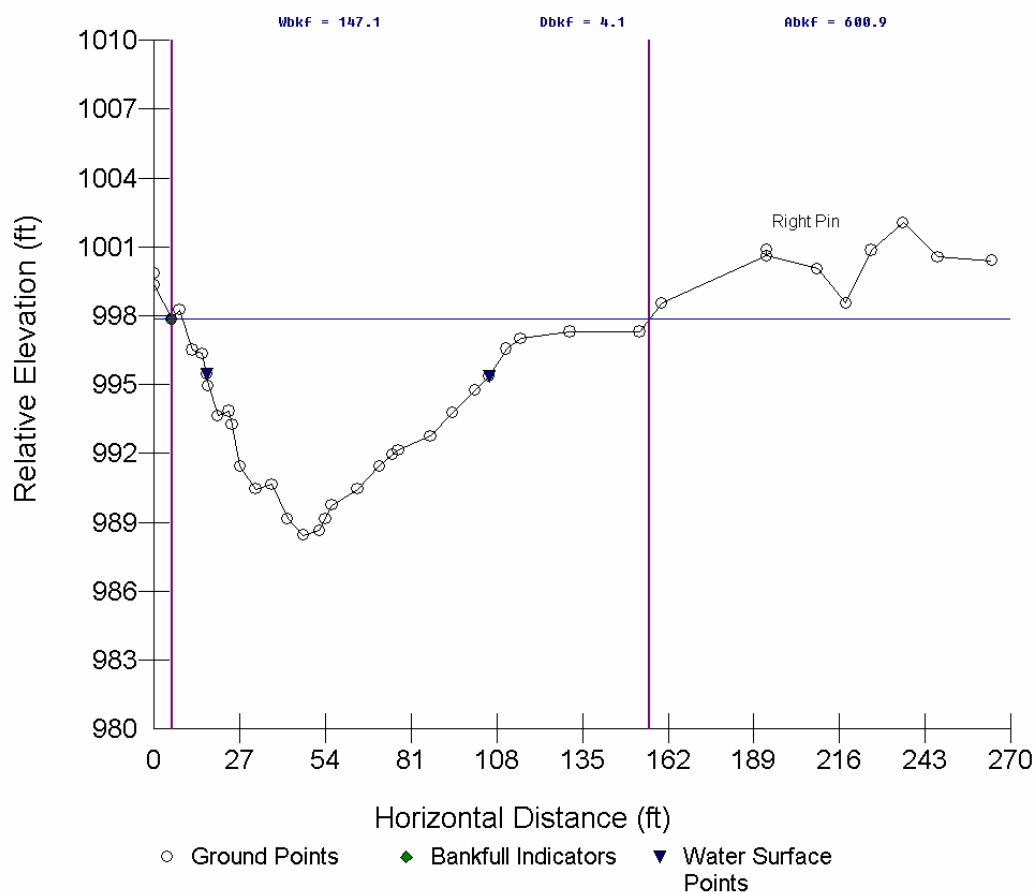
	Main Channel	Left Side Channel	Cumulative ¹
Bankfull Area (ft ²)	427	133	560
Width/Depth Ratio	53.4	18.4	35.9
Bankfull Width (ft)	151	49.6	201
Mean Depth (ft)	2.8	2.7	2.8
Max Depth (ft)	6.2	4.4	5.3

¹Cumulative values for area and width are sums while w/d ratio and depths are means.

Reach: **CFR near Clinton**Cross-Section: **11**Channel Unit: **Glide**

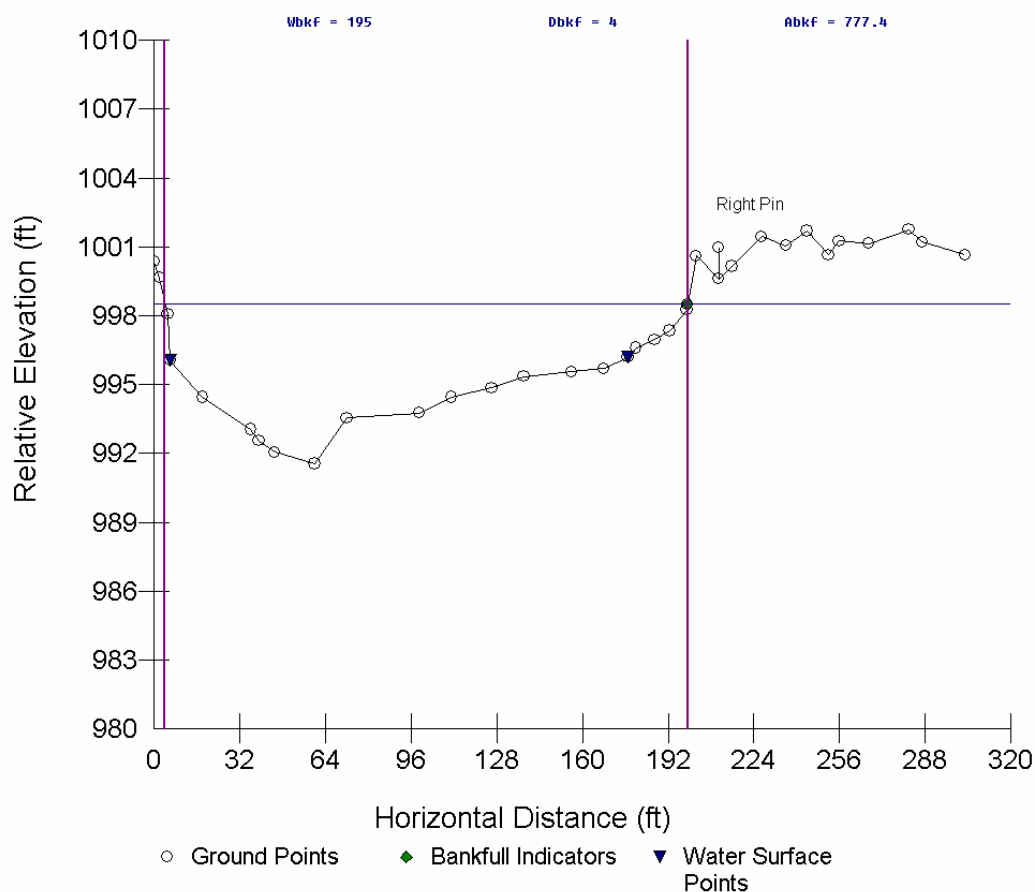
Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 11 (Glide)

	2006
Bankfull Area (ft ²)	768
Width/Depth Ratio	34.0
Bankfull Width (ft)	162
Mean Depth (ft)	4.8
Max Depth (ft)	7.7

Reach: **CFR near Clinton**Cross-Section: **12**Channel Unit: **Pool**

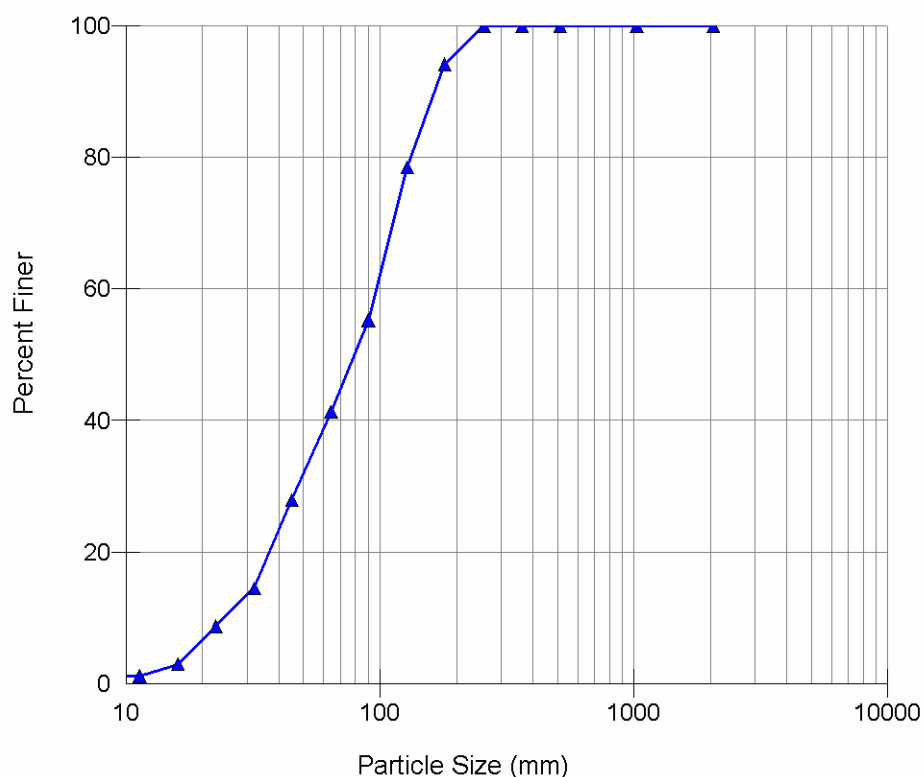
Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 12 (Pool)

	2006
Bankfull Area (ft ²)	601
Width/Depth Ratio	36.0
Bankfull Width (ft)	147
Mean Depth (ft)	4.1
Max Depth (ft)	9.4

Reach: **CFR near Clinton**Cross-Section: **13**Channel Unit: **Riffle**

Channel Cross-Section Summary Data (2006)
CFR near Clinton, Cross-Section 13 (Riffle)

	2006
Bankfull Area (ft ²)	777
Width/Depth Ratio	48.9
Bankfull Width (ft)	195
Mean Depth (ft)	4.0
Max Depth (ft)	7.0

Reach: CFR near ClintonCross-Section: 1 Channel Unit: Glide**Wolman Pebble Count**

Wolman Pebble Count Results (mm)
CFR near Clinton, Cross-Section 1 (Glide)

Size Class	XS 1 Glide
D16	33
D35	55
D50	80
D84	146
D95	191
D100	256

Riffle Stability Index (RSI) Results (mm)
CFR near Clinton, Point Bar near XS 1.

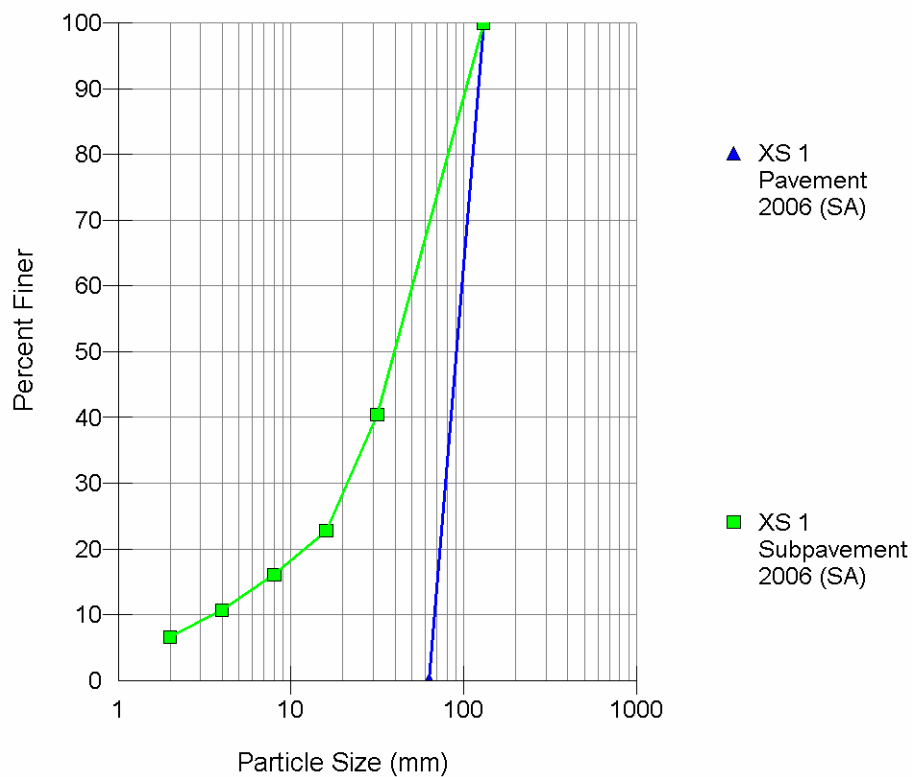
2006		
Max ¹	Mean ²	RSI Score ³
180	144	D82

¹ Maximum particle size sampled from downstream one-third of point bar

² Geometric mean of the 30 largest sampled particles

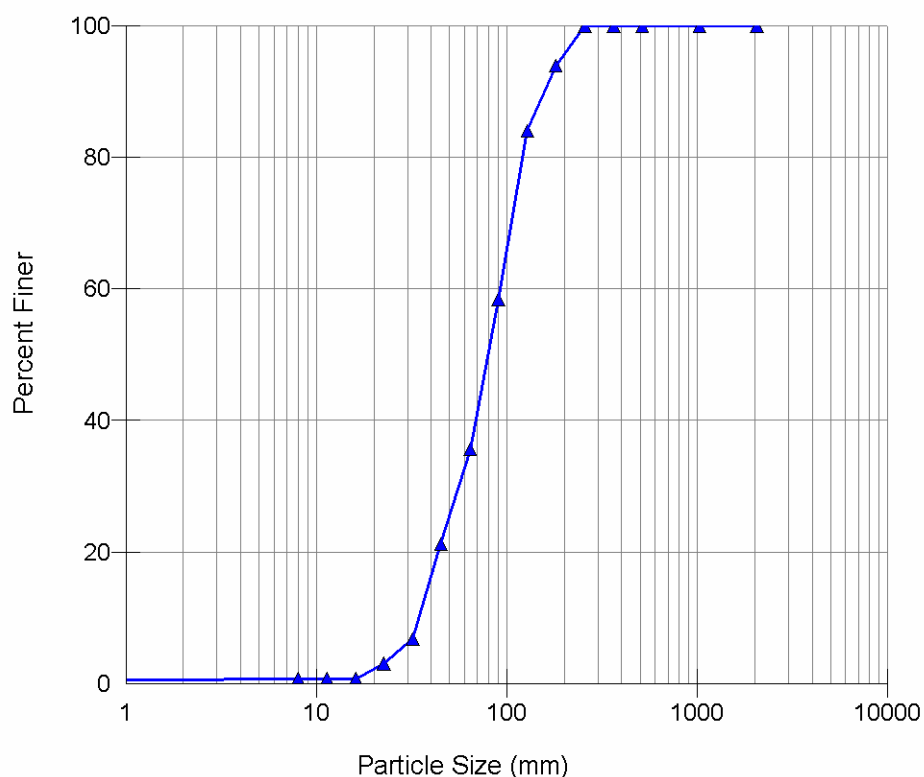
³ Riffle size class corresponding to mean particle size measured from RSI

Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR near Clinton, Cross-Section 1 (Point Bar)

Size Class	2006 Pavement	2006 Subpavement
D16	73	8
D35	86	27
D50	97	47
D84	119	104
D95	127	122
D100	130	130

Reach: **CFR near Clinton**Cross-Section: **6** Channel Unit: **Glide****Wolman Pebble Count**

Wolman Pebble Count Results (mm)
CFR near Clinton, Cross-Section 6 (Glide)

Size Class	XS 6 Glide
D16	40
D35	63
D50	80
D84	128
D95	193
D100	256

Riffle Stability Index (RSI) Results (mm)
CFR near Clinton, Point Bar near XS 12.

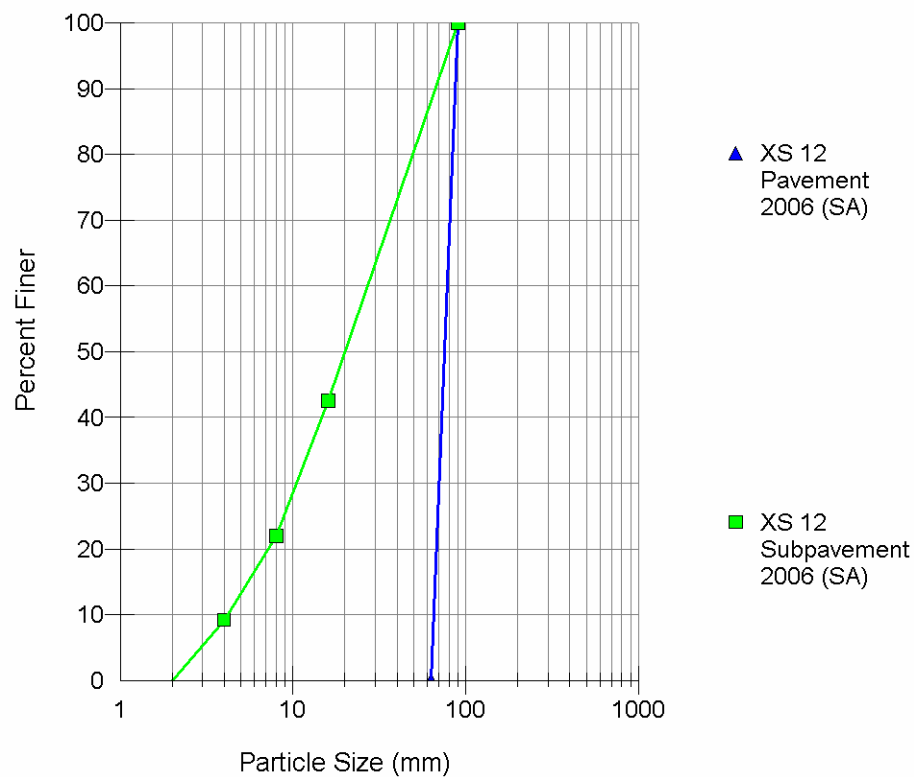
2006		
Max ¹	Mean ²	RSI Score ³
112	94	D66

¹ Maximum particle size sampled from downstream one-third of point bar

² Geometric mean of the 30 largest sampled particles

³ Riffle size class corresponding to mean particle size measured from RSI

Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR near Clinton, Cross-Section 12 (Point Bar)

Size Class	2006 Pavement	2006 Subpavement
D16	67	7
D35	72	16
D50	77	25
D84	86	67
D95	89	83
D100	90	90

Appendix B

CFR at Turah



REACH: CFR AT TURAH**Channel Cross-section Dimensions**

Reach	Cross-section Metric	Riffle			
		2004 Mean	Feb 2006 Mean	Aug 2006 Mean	Total Average
Turah	Bankfull Area (ft ²)	626.0	627.0	613.0	622.0
	Width/Depth Ratio	39.4	30.2	39.7	36.4
	Mean Depth (ft)	4.3	4.6	3.9	4.3
	Max Depth (ft)	7.3	6.8	6.9	7.0
	Width (ft)	157.1	137.6	156.0	150.2

ReachCross-section Metric		Glide									
		2004			Feb 2006			Aug 2006			Total
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Average
Turah	Bankfull Area (ft²)	884.0	884.0	884.0	880.0	882.0	884.0	880.0	901.0	922.0	889.0
	Width/Depth Ratio	31.2	31.2	31.2	33.7	33.7	33.7	32.1	33.6	35.0	32.8
	Mean Depth (ft)	5.3	5.3	5.3	5.1	5.1	5.1	5.1	5.2	5.2	5.0
	Max Depth (ft)	8.41	8.41	8.41	8.3	8.5	8.8	7.9	8.18	8.46	8.37
	Width (ft)	166.2	166.2	166.2	172.0	172.0	172.0	168.1	173.9	179.8	170.8

Channel Cross-section Dimensionless Ratios

2004 Data

Dimensionless Metric	Mean
Wfpa / Wbkf	1.97
Abkf	626.12
Dmbkf	7.30
Dbkf	3.99
Wbkf	157.08
Pool Area / Abkf	1.54
Max Pool Depth / Dbkf	2.22
Mean Pool Depth / Dbkf	1.24
Pool Width / Wbkf	1.25

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00283	0.00500	0.00917
S pool (ft/ft)	0.00018	0.00018	0.00018
S run (ft/ft)	0.00777	0.00777	0.00777
S glide (ft/ft)	0.00090	0.00090	0.00090
P - P (ft)	0.00	0.00	0.00
P length (ft)	167.71	167.71	167.71
Dmax riffle (ft)	3.29	5.17	6.74
Dmax pool (ft)	8.65	8.65	8.65
Dmax run (ft)	7.64	7.64	7.64
Dmax glide (ft)	6.24	6.24	6.24
Low Bank Ht (ft)	3.29	3.29	3.29
Bankfull Slope (ft/ft)		0.00278	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.02	1.80	3.30
S pool / S bkf (ft/ft)	0.06	0.06	0.06
S run / S bkf (ft/ft)	2.79	2.79	2.79
S glide / S bkf (ft/ft)	0.32	0.32	0.32
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	1.07	1.07	1.07
Dmax riffle / D bkf (ft)	0.82	1.30	1.69
Dmax pool / D bkf (ft)	2.17	2.17	2.17
Dmax run / D bkf (ft)	1.91	1.91	1.91
Dmax glide / D bkf (ft)	1.56	1.56	1.56
Low Bank Ht / Dmax riff (ft)	0.64	0.64	0.64
Bankfull Slope (ft/ft)		0.00278	

2006 Data

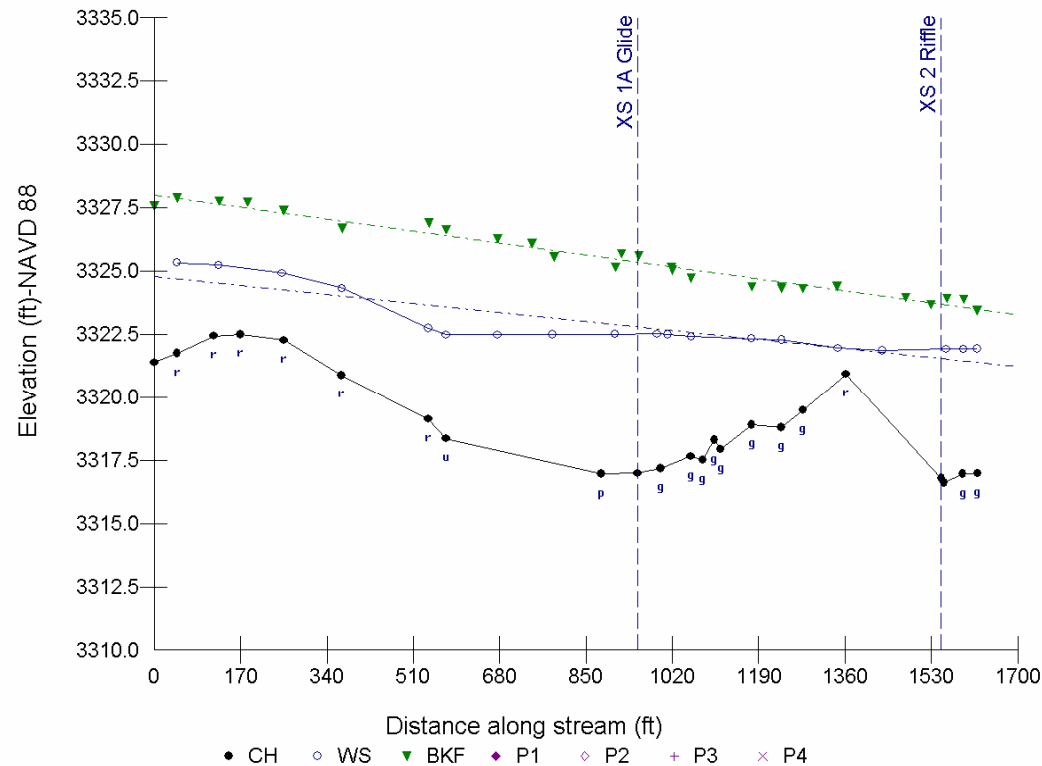
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00487	0.00562	0.00637
S pool (ft/ft)	0.00056	0.00056	0.00056
S run (ft/ft)	0.00125	0.00125	0.00125
S glide (ft/ft)	0.00136	0.00142	0.00148
P - P (ft)	0.00	0.00	0.00
P length (ft)	359.42	359.42	359.42
Dmax riffle (ft)	3.65	4.00	4.25
Dmax pool (ft)	9.54	9.54	9.54
Dmax run (ft)	5.98	6.89	7.90
Dmax glide (ft)	4.56	6.69	8.81
Low Bank Ht (ft)	3.75	3.75	3.75
Bankfull Slope (ft/ft)		0.00252	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.93	2.23	2.53
S pool / S bkf (ft/ft)	0.22	0.22	0.22
S run / S bkf (ft/ft)	0.50	0.50	0.50
S glide / S bkf (ft/ft)	0.54	0.56	0.59
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	2.30	2.30	2.30
Dmax riffle / D bkf (ft)	0.93	1.02	1.08
Dmax pool / D bkf (ft)	2.43	2.43	2.43
Dmax run / D bkf (ft)	1.52	1.75	2.01
Dmax glide / D bkf (ft)	1.16	1.70	2.24
Low Bank Ht / Dmax riff (ft)	0.94	0.94	0.94
Bankfull Slope (ft/ft)		0.00252	

Channel Planform Dimensions and Dimensionless Ratios

Year	Sinuosity (ft/ft)	Meander Belt Width (ft)	Meander Belt Width (ft) / Wbkf
1937	1.08	888	5.66
1956	1.11	579	3.69
1966	1.1	418	2.66
2000	1.15	489	3.11
2005	1.15	529	3.37

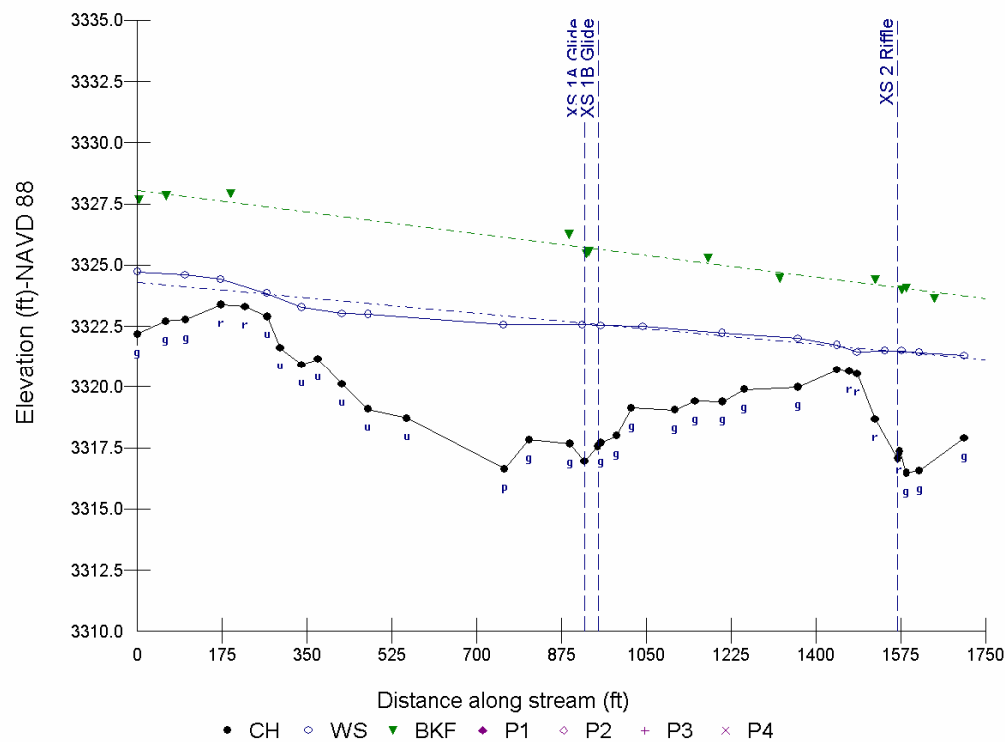
CFR Turah 2004



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00283	0.00500	0.00917
S pool (ft/ft)	0.00018	0.00018	0.00018
S run (ft/ft)	0.00777	0.00777	0.00777
S glide (ft/ft)	0.00090	0.00090	0.00090
P - P (ft)	0.00	0.00	0.00
P length (ft)	167.71	167.71	167.71
Dmax riffle (ft)	3.29	5.17	6.74
Dmax pool (ft)	8.65	8.65	8.65
Dmax run (ft)	7.64	7.64	7.64
Dmax glide (ft)	6.24	6.24	6.24
Low Bank Ht (ft)	3.29	3.29	3.29
Bankfull Slope (ft/ft)		0.00278	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.02	1.80	3.30
S pool / S bkf (ft/ft)	0.06	0.06	0.06
S run / S bkf (ft/ft)	2.79	2.79	2.79
S glide / S bkf (ft/ft)	0.32	0.32	0.32
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	1.07	1.07	1.07
Dmax riffle / D bkf (ft)	0.82	1.30	1.69
Dmax pool / D bkf (ft)	2.17	2.17	2.17
Dmax run / D bkf (ft)	1.91	1.91	1.91
Dmax glide / D bkf (ft)	1.56	1.56	1.56
Low Bank Ht / Dmax riff (ft)	0.64	0.64	0.64
Bankfull Slope (ft/ft)		0.00278	

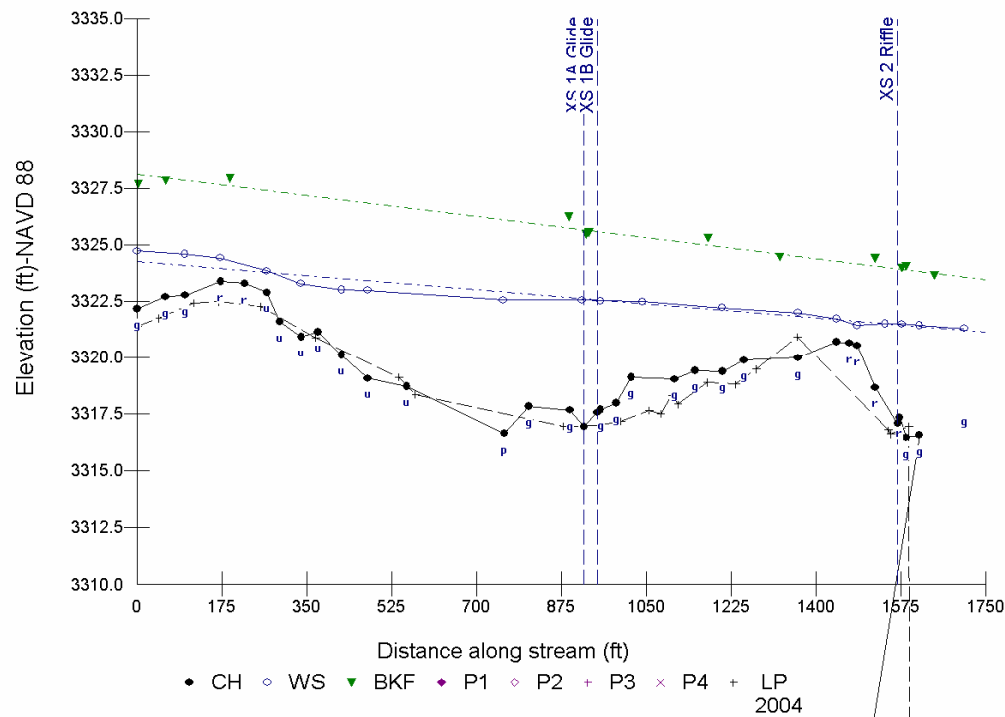
CFR Turah 2006



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00487	0.00562	0.00637
S pool (ft/ft)	0.00056	0.00056	0.00056
S run (ft/ft)	0.00125	0.00125	0.00125
S glide (ft/ft)	0.00136	0.00142	0.00148
P - P (ft)	0.00	0.00	0.00
P length (ft)	359.42	359.42	359.42
Dmax riffle (ft)	3.65	4.00	4.25
Dmax pool (ft)	9.54	9.54	9.54
Dmax run (ft)	5.98	6.89	7.90
Dmax glide (ft)	4.56	6.69	8.81
Low Bank Ht (ft)	3.75	3.75	3.75
Bankfull Slope (ft/ft)		0.00252	

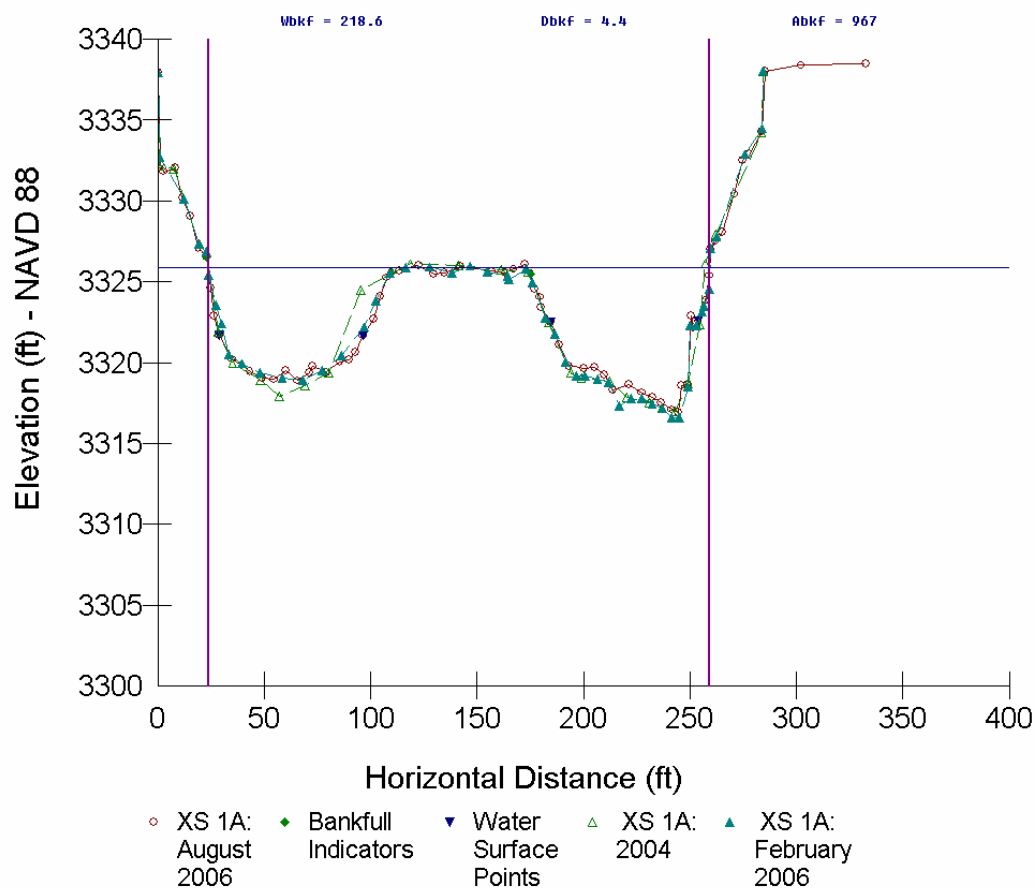
Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.93	2.23	2.53
S pool / S bkf (ft/ft)	0.22	0.22	0.22
S run / S bkf (ft/ft)	0.50	0.50	0.50
S glide / S bkf (ft/ft)	0.54	0.56	0.59
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	2.30	2.30	2.30
Dmax riffle / D bkf (ft)	0.93	1.02	1.08
Dmax pool / D bkf (ft)	2.43	2.43	2.43
Dmax run / D bkf (ft)	1.52	1.75	2.01
Dmax glide / D bkf (ft)	1.16	1.70	2.24
Low Bank Ht / Dmax riff (ft)	0.94	0.94	0.94
Bankfull Slope (ft/ft)		0.00252	

CFR Turah 2004 and 2006



Profile Dimensions Metric	2004 Mean	2006 Mean	Difference (+/-)
S riffle (ft/ft)	0.00500	0.00562	0.00062
S pool (ft/ft)	0.00018	0.00056	0.00038
S run (ft/ft)	0.00777	0.00125	-0.00652
S glide (ft/ft)	0.00090	0.00142	0.00052
P - P (ft)	0.00	0.00	0.00000
P length (ft)	167.71	359.42	191.71
Dmax riffle (ft)	5.17	4.00	-1.17
Dmax pool (ft)	8.65	9.54	0.89
Dmax run (ft)	7.64	6.89	-0.75
Dmax glide (ft)	6.24	6.69	0.45
Low Bank Ht (ft)	3.29	3.75	0.46
Bankfull Slope (ft/ft)	0.00278	0.00252	0.00

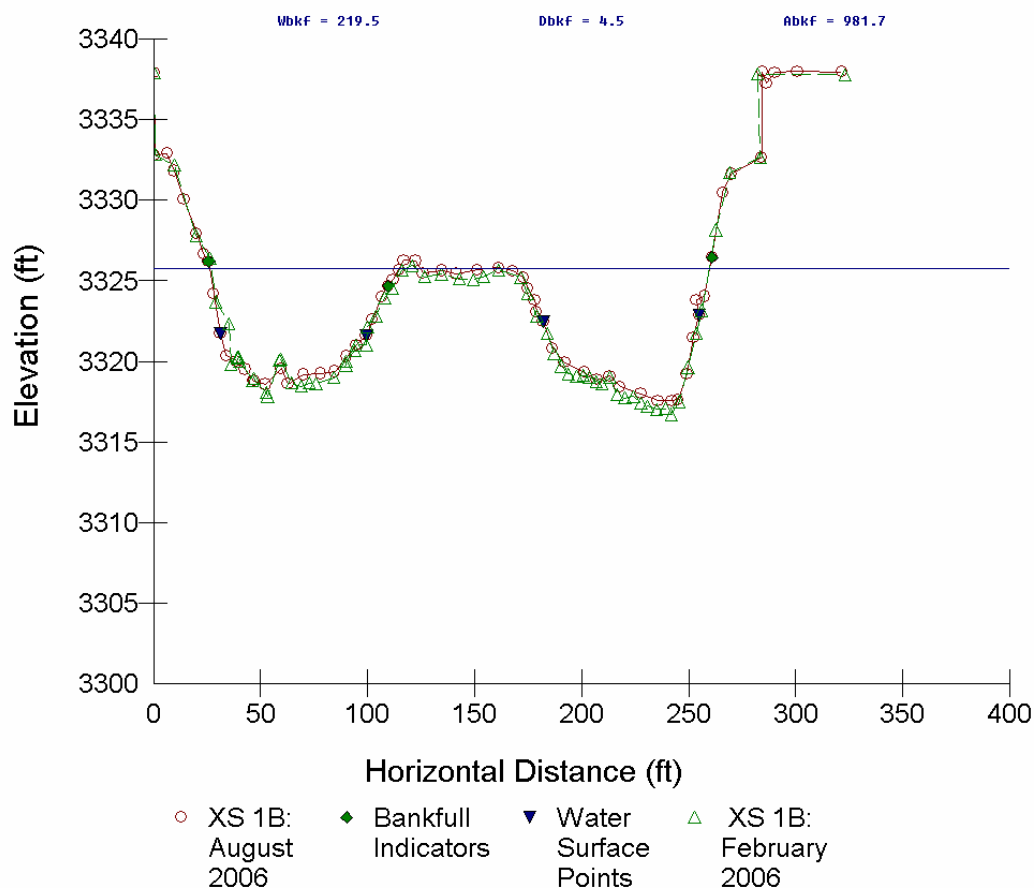
Profile Dimensionless Metric	2004 Mean	2006 Mean	Difference (+/-)
S riffle / S bkf (ft/ft)	1.80	2.23	0.43
S pool / S bkf (ft/ft)	0.06	0.22	0.16
S run / S bkf (ft/ft)	2.79	0.50	-2.30
S glide / S bkf (ft/ft)	0.32	0.56	0.24
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	1.07	2.30	1.24
Dmax riffle / D bkf (ft)	1.30	1.02	-0.28
Dmax pool / D bkf (ft)	2.17	2.43	0.26
Dmax run / D bkf (ft)	1.91	1.75	-0.16
Dmax glide / D bkf (ft)	1.56	1.70	0.14
Low Bank Ht / Dmax riff (ft)	0.64	0.94	0.30
Bankfull Slope (ft/ft)	0.00278	0.00252	0.00

Reach: **CFR at Turah**Cross-Section: **1A**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR at Turah, Cross-Section 1A (Glide)

	2004	Feb 2006	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	884	884	880	883	-0.5
Width/Depth Ratio	31.2	33.7	32.1	32.3	+2.9
Bankfull Width (ft)	166	172	168	162	+1.1
Mean Depth (ft)	5.3	5.1	5.2	5.2	-1.7

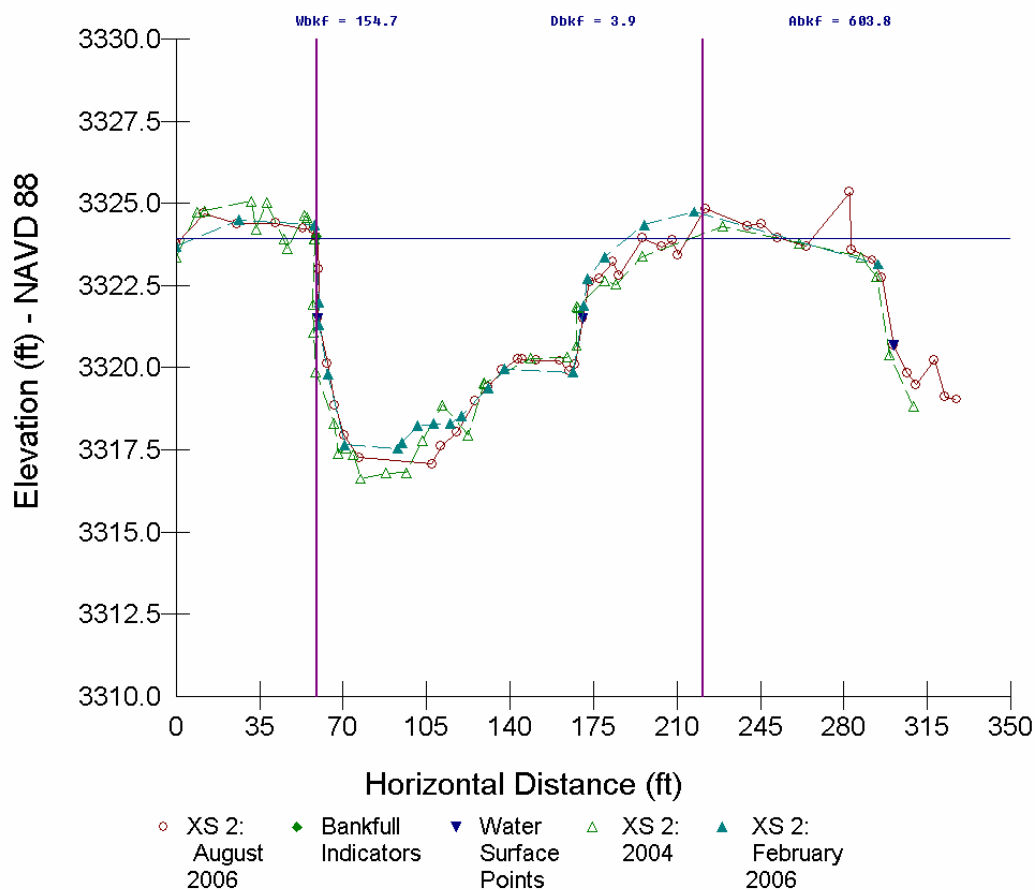
¹ Change from 2004 to 2006

Reach: **CFR at Turah**Cross-Section: **1B**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR at Turah, Cross-Section 1B (Glide)

	2004	Feb 2006	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	n/a	880	922	901	+4.8
Width/Depth Ratio	n/a	33.7	35.0	34.4	+3.9
Bankfull Width (ft)	n/a	172	180	176	+4.5
Mean Depth (ft)	n/a	5.1	5.1	5.1	0.0

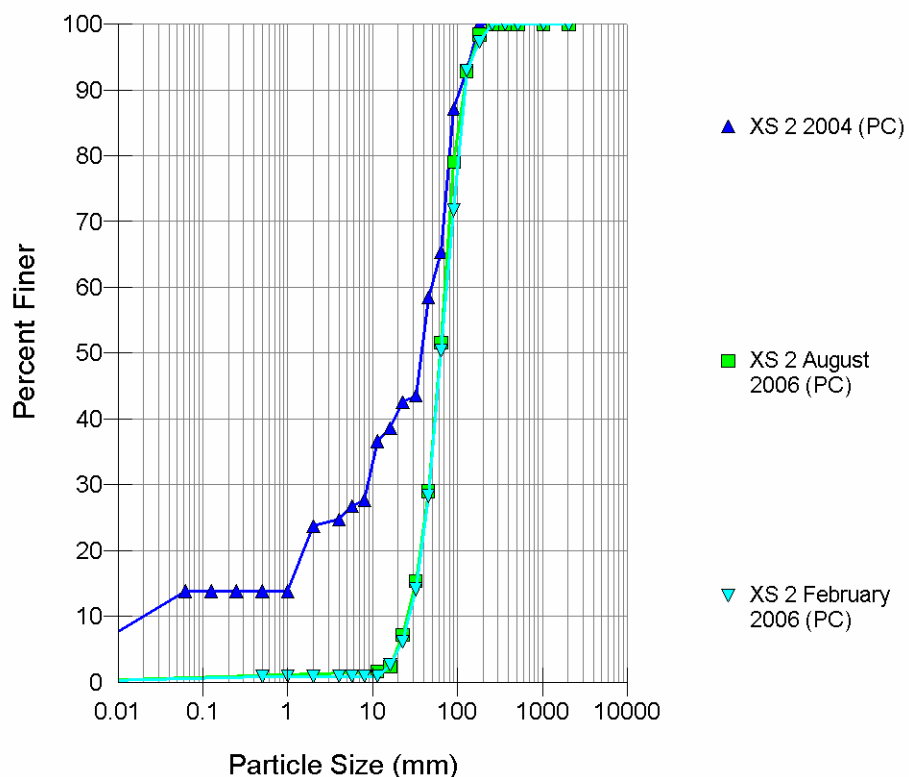
¹ Change from 2005 to 2006

Reach: **CFR at Turah**Cross-Section: **2**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR at Turah, Cross-Section 2 (Riffle)

	2004	Feb 2006	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	626	627	613	622	-2.1
Width/Depth Ratio	39.4	30.2	39.7	36.4	+0.8
Bankfull Width (ft)	157	138	156	150	-0.7
Mean Depth (ft)	4.3	4.6	3.9	4.3	-9.0

¹ Change from 2004 to 2006

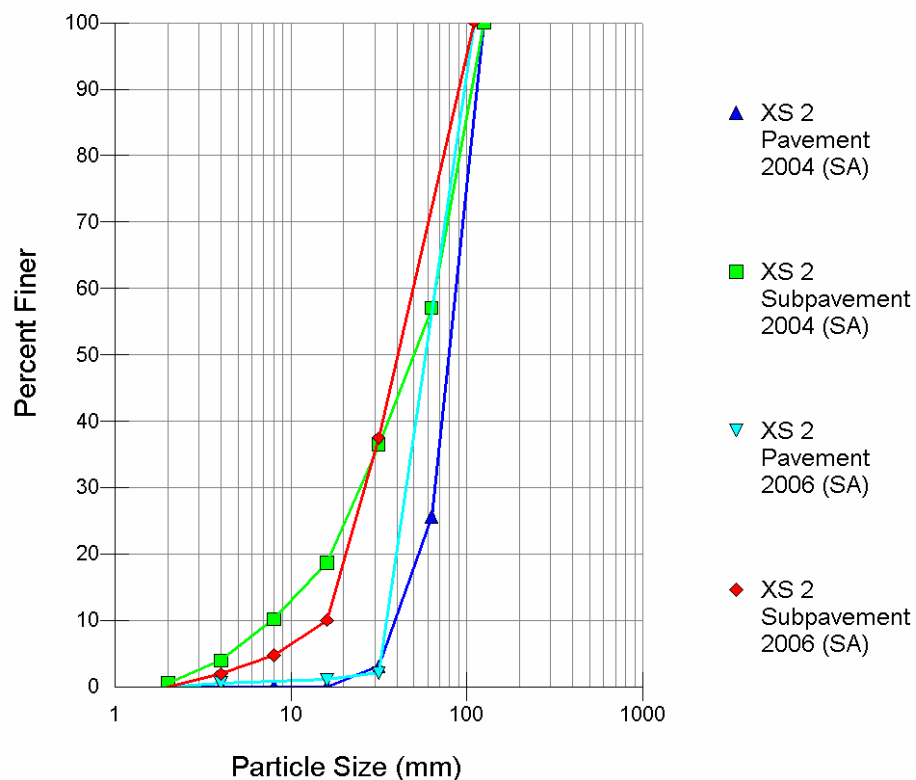
Reach: CFR at TurahCross-Section: 2Channel Unit: Riffle**Wolman Pebble Count**

Wolman Pebble Count Results (mm)				
CFR at Turah Bridge, Cross-Section 2 (Riffle)				
Size Class	2004	Feb 2006	Aug 2006	Mean
D16	1	34	33	23
D35	11	51	50	37
D50	38	64	63	55
D84	86	112	104	101
D95	142	152	149	148
D100	180	256	256	231

Riffle Stability Index (RSI) Results (mm)					
CFR at Turah					
2004			2006		
Max ¹	Mean ²	RSI Score ³	Max	Mean	RSI Score
230	176	D95	250	209	D98

¹ Maximum particle size sampled from downstream one-third of point bar² Geometric mean of the 30 largest sampled particles³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement

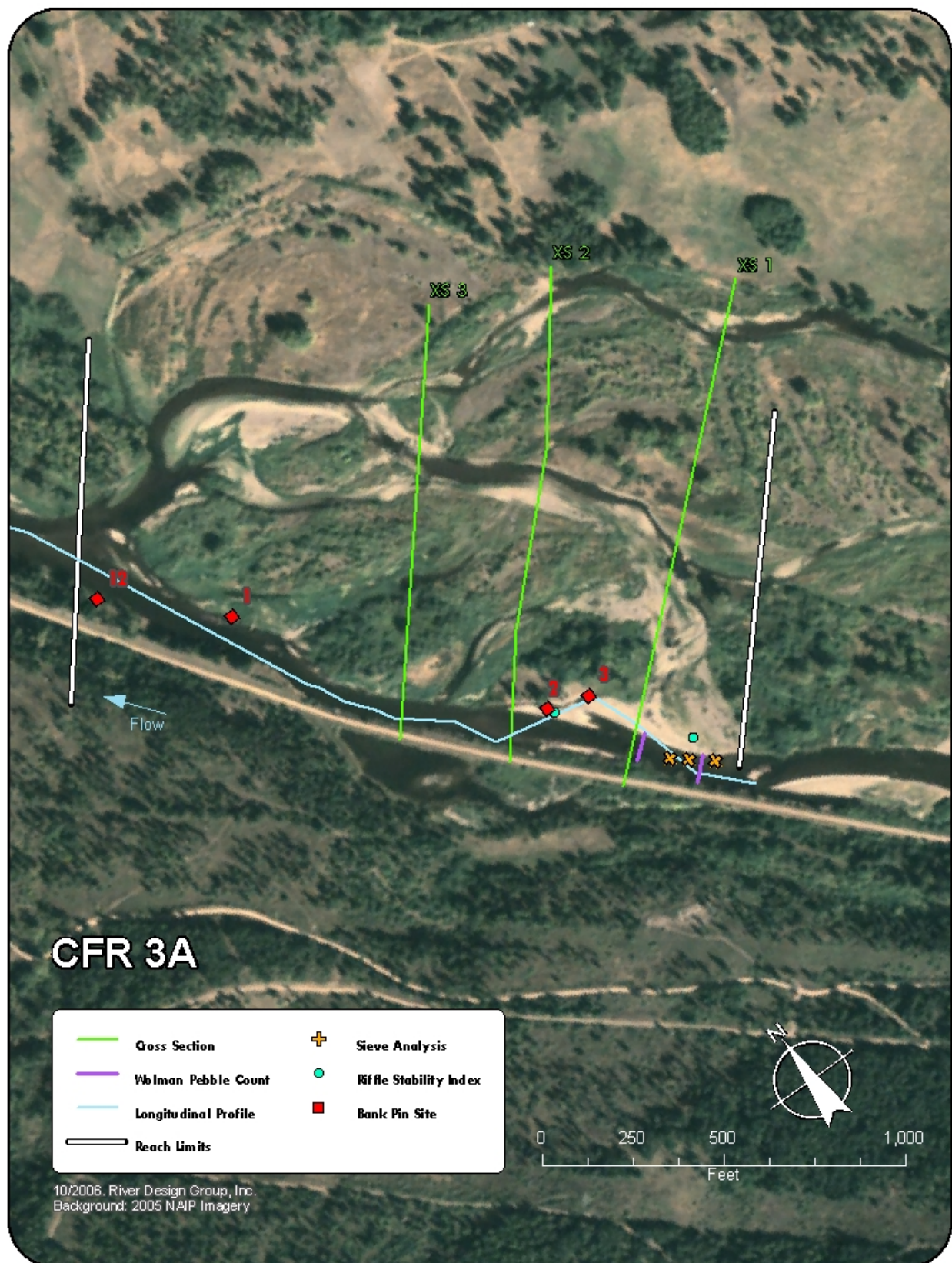


Substrate Pavement and Subpavement (mm)
CFR at Turah Bridge, Cross-Section 2 (Riffle)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	50	13	48	20
D35	71	30	67	31
D50	83	52	77	41
D84	112	102	99	67
D95	121	118	107	97
D100	135	135	110	110

Appendix C

CFR 3A



REACH: CFR 3A**Channel Cross-section Dimensions**

Reach	Cross-section Metric	Riffle						Total Average
		Min	2004 Mean	Max	Min	Aug 2006 Mean	Max	
CFR 3A	Bankfull Area (ft ²)	1128.0	1217.3	1387.0	1322.0	1409.7	1583.0	1313.5
	Width/Depth Ratio	351.0	413.7	451.0	358.0	404.0	490.0	408.8
	Mean Depth (ft)	1.6	1.7	1.8	1.8	1.9	1.9	1.8
	Max Depth (ft)	5.4	6.4	7.7	5.1	5.9	6.5	6.1
	Width (ft)	632.4	708.7	780.8	686.9	754.3	881.6	731.5

Channel Cross-section Dimensionless Ratios**2004 Data**

Dimensionless Metric	Mean
Wfpa / Wbkf	1.74
Abkf	1128.28
Dmbkf	5.4
Dbkf	1.58
Wbkf	632.61

2006 Data

Dimensionless Metric	Min	Mean	Max
Wfpa / Wbkf	1.85	1.94	2.03
Abkf	807.25	1261.70	1654.00
Dmbkf	5.14	6.17	6.79
Dbkf	1.83	1.92	2.00
Wbkf	402.99	665.65	904.94

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00377	0.00999	0.01662
S pool (ft/ft)	0.00000	0.00000	0.00000
S run (ft/ft)	0.00059	0.00623	0.01517
S glide (ft/ft)	0.00373	0.00582	0.01153
P - P (ft)	0.00	0.00	0.00
P length (ft)	0.00	0.00	0.00
Dmax riffle (ft)	3.60	4.47	6.89
Dmax pool (ft)	0.00	0.00	0.00
Dmax run (ft)	4.94	6.52	7.48
Dmax glide (ft)	4.66	4.99	5.21
Low Bank Ht (ft)	3.82	3.82	3.82
Bankfull Slope (ft/ft)		0.004	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.94	2.50	4.16
S pool / S bkf (ft/ft)	0.00	0.00	0.00
S run / S bkf (ft/ft)	0.15	1.56	3.79
S glide / S bkf (ft/ft)	0.93	1.46	2.88
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	0.00	0.00	0.00
Dmax riffle / D bkf (ft)	2.09	2.60	4.01
Dmax pool / D bkf (ft)	0.00	0.00	0.00
Dmax run / D bkf (ft)	2.87	3.79	4.35
Dmax glide / D bkf (ft)	2.71	2.90	3.03
Low Bank Ht / Dmax riff (ft)	0.85	0.85	0.85
Bankfull Slope (ft/ft)		0.004	

2006 Data

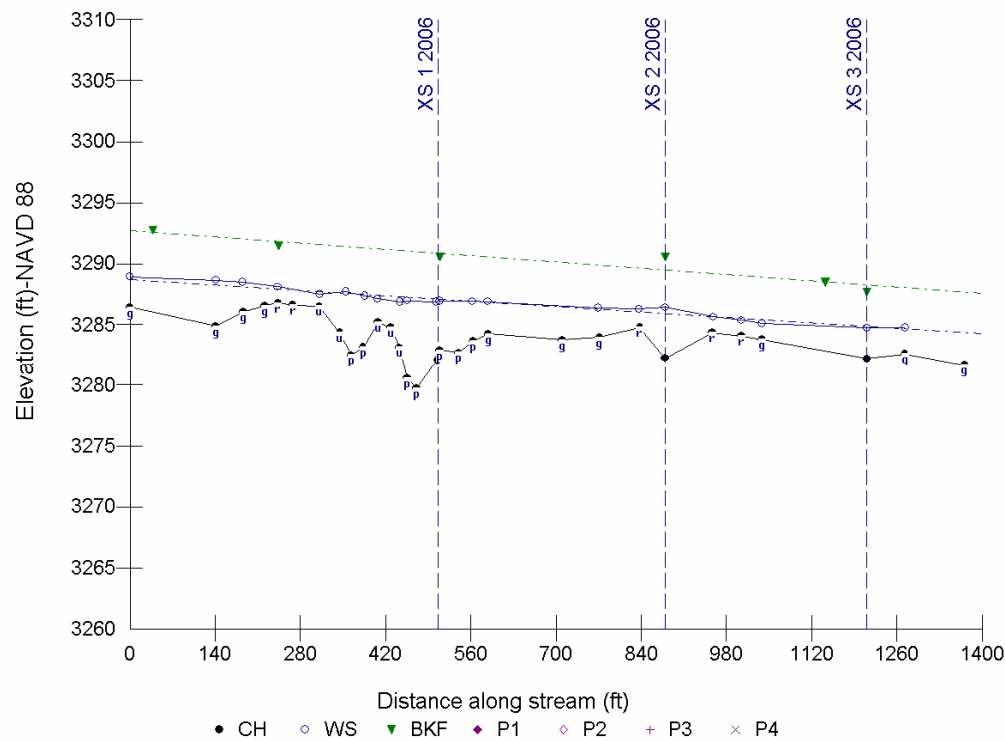
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00736	0.00942	0.01148
S pool (ft/ft)	0.00147	0.00152	0.00156
S run (ft/ft)	0.00832	0.00832	0.00832
S glide (ft/ft)	0.00312	0.00503	0.00693
P - P (ft)	105.94	105.94	105.94
P length (ft)	51.46	59.03	66.59
Dmax riffle (ft)	4.75	4.89	5.00
Dmax pool (ft)	8.74	9.95	11.15
Dmax run (ft)	5.00	6.60	7.85
Dmax glide (ft)	5.38	6.00	6.40
Low Bank Ht (ft)	4.75	4.85	4.94
Bankfull Slope (ft/ft)		0.00373	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.97	2.53	3.08
S pool / S bkf (ft/ft)	0.39	0.41	0.42
S run / S bkf (ft/ft)	2.23	2.23	2.23
S glide / S bkf (ft/ft)	0.84	1.35	1.86
P - P / W bkf (ft)	0.16	0.16	0.16
P length / W bkf (ft)	0.08	0.09	0.10
Dmax riffle / D bkf (ft)	2.47	2.55	2.60
Dmax pool / D bkf (ft)	4.55	5.18	5.81
Dmax run / D bkf (ft)	2.60	3.44	4.09
Dmax glide / D bkf (ft)	2.80	3.13	3.33
Low Bank Ht / Dmax riff (ft)	0.97	0.99	1.01
Bankfull Slope (ft/ft)		0.00373	

Channel Planform Dimensions and Dimensionless Ratios

Year	Sinuosity (ft/ft)	Meander Belt Width (ft)	Meander Belt Width (ft) / Wbkf ^Λ
1937	1.36	1171	8.94
1956	1.52	1342	10.24
1966	1.52	1325	10.11
2000	1.25	1108	8.46
2005	1.02	825	6.30

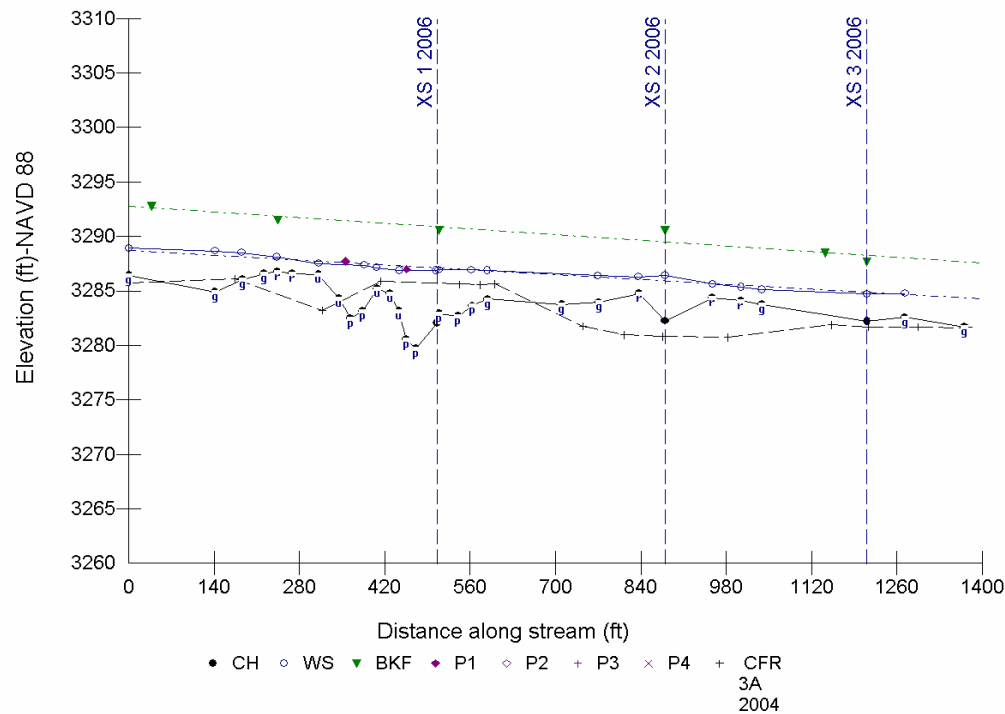
CFR 3A 2006



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00736	0.00942	0.01148
S pool (ft/ft)	0.00147	0.00152	0.00156
S run (ft/ft)	0.00832	0.00832	0.00832
S glide (ft/ft)	0.00312	0.00503	0.00693
P - P (ft)	105.94	105.94	105.94
P length (ft)	51.46	59.03	66.59
Dmax riffle (ft)	4.75	4.89	5.00
Dmax pool (ft)	8.74	9.95	11.15
Dmax run (ft)	5.00	6.60	7.85
Dmax glide (ft)	5.38	6.00	6.40
Low Bank Ht (ft)	4.75	4.85	4.94
Bankfull Slope (ft/ft)		0.00373	

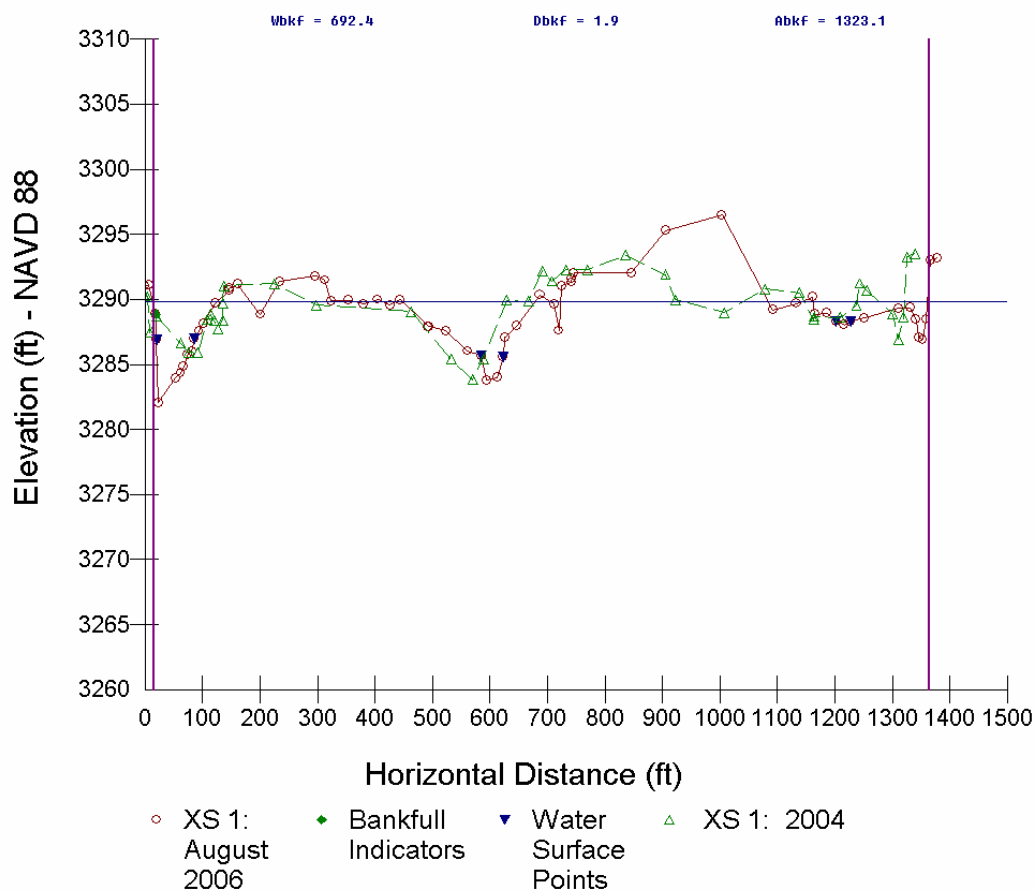
Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.97	2.53	3.08
S pool / S bkf (ft/ft)	0.39	0.41	0.42
S run / S bkf (ft/ft)	2.23	2.23	2.23
S glide / S bkf (ft/ft)	0.84	1.35	1.86
P - P / W bkf (ft)	1.03	1.03	1.03
P length / W bkf (ft)	0.50	0.57	0.64
Dmax riffle / D bkf (ft)	1.22	1.26	1.29
Dmax pool / D bkf (ft)	2.25	2.56	2.87
Dmax run / D bkf (ft)	1.29	1.70	2.02
Dmax glide / D bkf (ft)	1.38	1.54	1.65
Low Bank Ht / Dmax riff (ft)	0.97	0.99	1.01
Bankfull Slope (ft/ft)		0.00373	

CFR 3A 2004 and 2006



Profile Dimensions Metric	2004 Mean	2006 Mean	Difference (+/-)
S riffle (ft/ft)	0.00999	0.00942	-0.00057
S pool (ft/ft)	0.00000	0.00152	0.00152
S run (ft/ft)	0.00623	0.00832	0.00209
S glide (ft/ft)	0.00582	0.00503	-0.00079
P - P (ft)	0.00	105.94	105.94
P length (ft)	0.00	59.03	59.03
Dmax riffle (ft)	4.47	4.89	0.42
Dmax pool (ft)	0.00	9.95	9.95
Dmax run (ft)	6.52	6.60	0.08
Dmax glide (ft)	4.99	6.00	1.01
Low Bank Ht (ft)	3.82	4.85	1.03000
Bankfull Slope (ft/ft)	0.004	0.00373	-0.00027

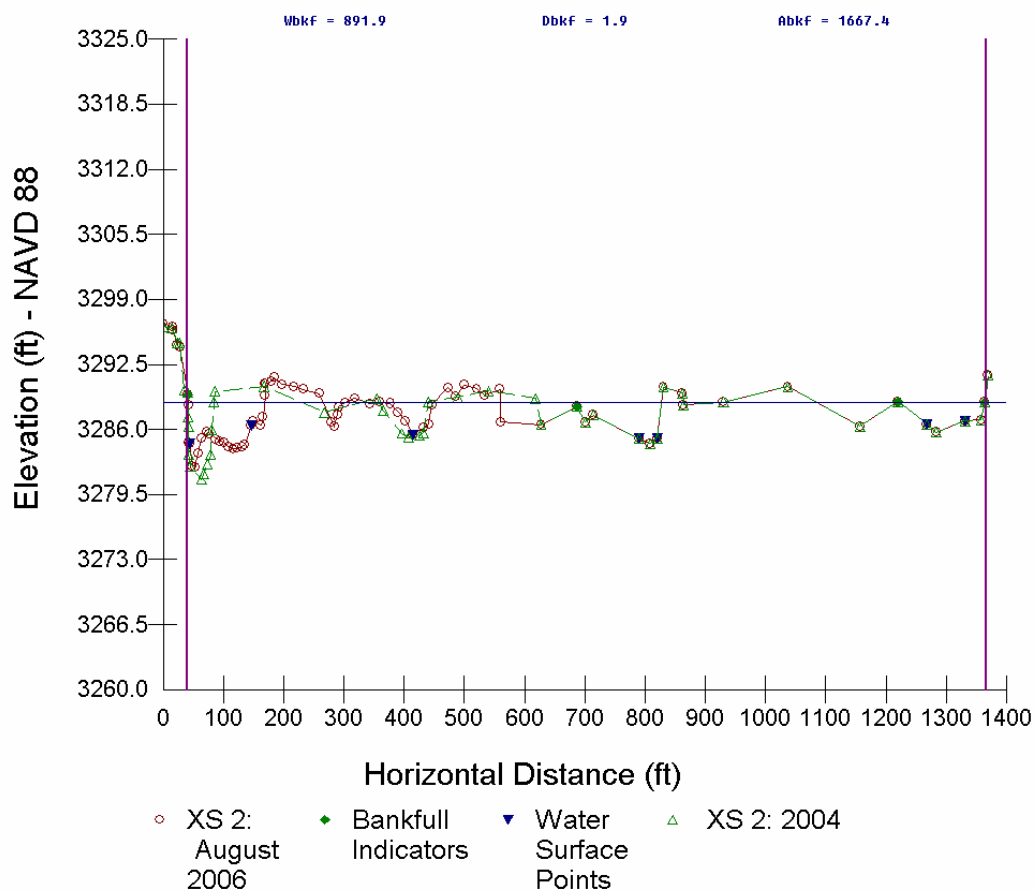
Profile Dimensionless Metric	2004 Mean	2006 Mean	Difference (+/-)
S riffle / S bkf (ft/ft)	2.50	2.53	0.03
S pool / S bkf (ft/ft)	0.00	0.41	0.41
S run / S bkf (ft/ft)	1.56	2.23	0.67
S glide / S bkf (ft/ft)	1.46	1.35	-0.11
P - P / W bkf (ft)	0.00	1.03	1.03
P length / W bkf (ft)	0.00	0.57	0.57
Dmax riffle / D bkf (ft)	1.89	1.26	-0.64
Dmax pool / D bkf (ft)	0.00	2.56	2.56
Dmax run / D bkf (ft)	2.76	1.70	-1.07
Dmax glide / D bkf (ft)	2.11	1.54	-0.57
Low Bank Ht / Dmax riff (ft)	0.85	0.99	0.14
Bankfull Slope (ft/ft)	0.004	0.00373	0.00

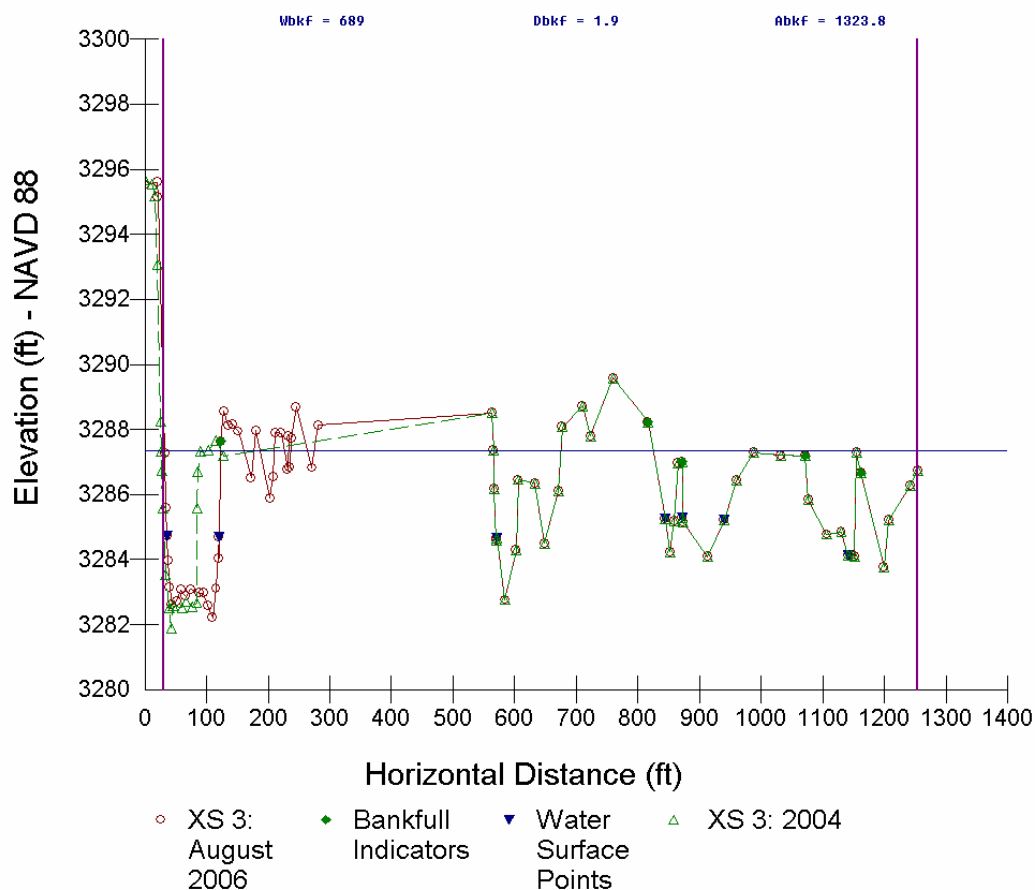
Reach: **CFR 3A**Cross-Section: **1**Channel Unit: **Riffle**

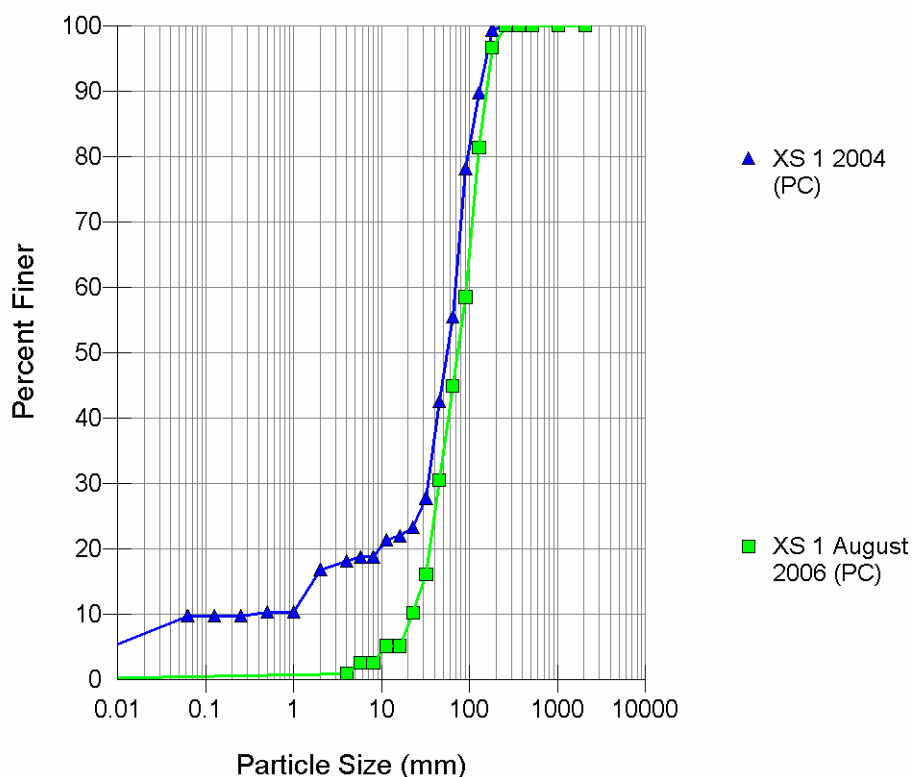
Channel Cross-section Summary Data
CFR 3A, Cross-section 1 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1128	1324	1226	+17.4
Width/Depth Ratio	451	364	408	-19.3
Bankfull Width (ft)	713	695	704	-2.6
Mean Depth (ft)	1.6	1.9	1.7	+20.9

¹ Change from 2004 to 2006

Reach: **CFR 3A**Cross-Section: **2**Channel Unit: **Riffle**

Reach: **CFR 3A**Cross-Section: **3**Channel Unit: **Riffle**

Reach: **CFR 3A**Cross-Section: **1**Channel Unit: **Riffle****Wolman Pebble Count**

Wolman Pebble Count Results (mm)

CFR 3A, Cross-Section 1 (Riffle)

Size Class	2004	Feb 2006	Aug 2006	Mean
D16	2	n/a	32	17
D35	38	n/a	51	45
D50	56	n/a	74	65
D84	109	n/a	137	123
D95	157	n/a	175	116
D100	256	n/a	256	256

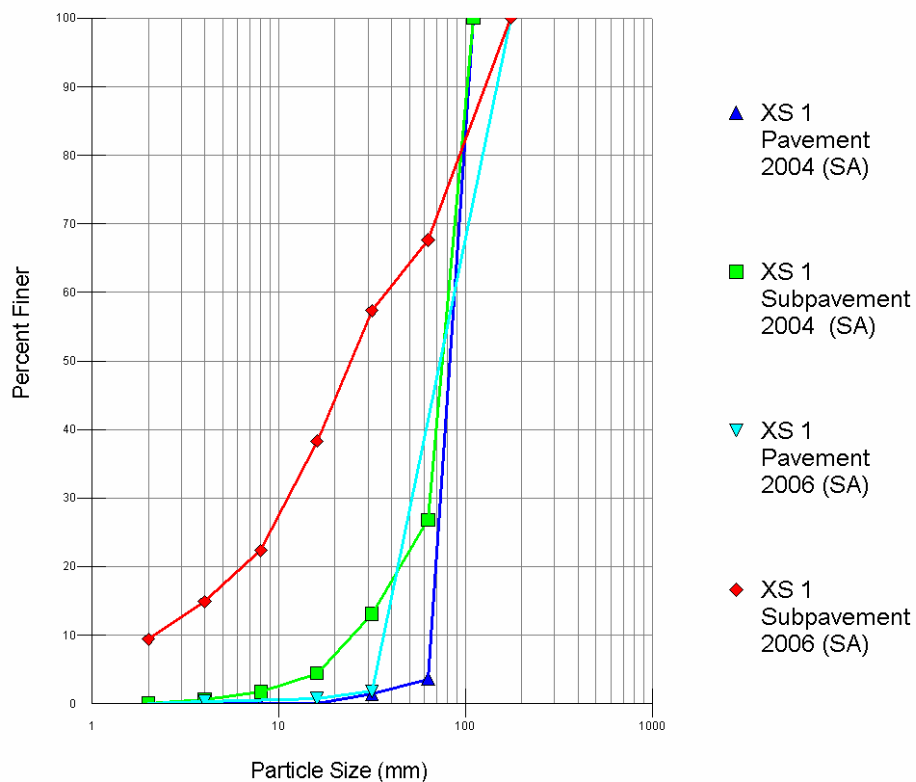
Riffle Stability Index (RSI) Results (mm)

CFR 3A

2004			2006		
Max ¹	Mean ²	RSI Score ³	Max	Mean	RSI Score
155	121	D86	212	159	D85

¹ Maximum particle size sampled from downstream one-third of point bar² Geometric mean of the 30 largest sampled particles³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement

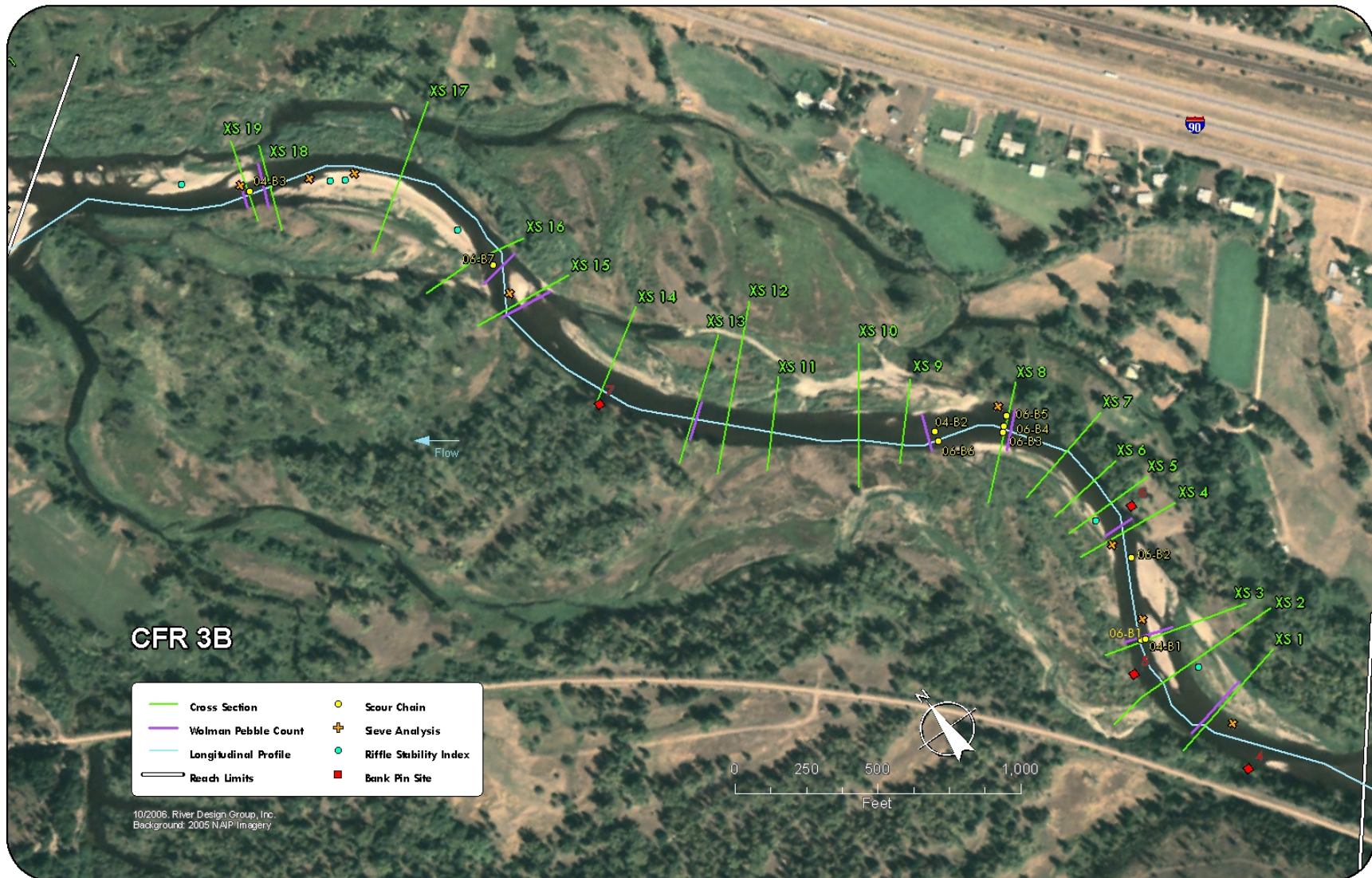


Substrate Pavement and Subpavement (mm)
CFR 3A, Cross-Section 1 (Riffle)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	69	38	52	5
D35	78	68	79	14
D50	86	78	101	26
D84	102	100	151	120
D95	108	107	168	158
D100	110	110	175	175

Appendix D

CFR 3B



REACH: CFR 3B**Channel Cross-section Dimensions**

		Riffle									
		2004			Feb 2006			Aug 2006			Total
Reach	Cross-section Metric	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Average
CFR 3B Reference	Bankfull Area (ft²)	467.0	535.7	673.0	482.0	536.8	593.0	459.0	553.0	643.0	541.8
	Width/Depth Ratio	31.8	45.8	68.6	32.0	38.2	44.4	29.9	45.2	75.0	43.0
	Mean Depth (ft)	2.9	3.5	4.3	3.3	3.8	4.3	2.9	3.6	4.2	3.6
	Max Depth (ft)	3.9	5.4	6.2	5.1	5.6	6.1	4.3	5.1	5.6	5.4
	Width (ft)	138.0	155.6	214.7	137.8	142.2	148.0	121.0	156.5	220.0	151.4

		Run						
		2004			Aug 2006			Total
Reach	Cross-section Metric	Min	Mean	Max	Min	Mean	Max	Average
CFR 3B Reference	Bankfull Area (ft²)	384.0	503.5	616.0	363.0	475.7	564.0	489.6
	Width/Depth Ratio	27.3	41.3	54.9	34.1	41.5	45.9	41.4
	Mean Depth (ft)	2.93	3.59	4.75	2.9	3.4	4.1	3.5
	Max Depth (ft)	3.72	6.165	7.82	3.36	5.60	7.03	5.88
	Width (ft)	125.5	141.7	160.7	127.0	139.0	151.4	140.3

		Pool						
		2004			Aug 2006			Total
Reach	Cross-section Metric	Min	Mean	Max	Min	Mean	Max	Average
CFR 3B Reference	Bankfull Area (ft²)	492	610.7	804	474.0	545.5	617.0	578.1
	Width/Depth Ratio	35.9	46.1	62.5	53.5	53.5	53.5	49.8
	Mean Depth (ft)	2.93	3.7	4.73	3.0	3.0	3.1	3.4
	Max Depth (ft)	4.66	6.5	7.85	4.44	5.35	6.26	5.9
	Width (ft)	140.4	164.1	183.0	159.4	161.8	164.2	163.0

		Glide						
		2004			Aug 2006			Total
Reach	Cross-section Metric	Min	Mean	Max	Min	Mean	Max	Average
CFR 3B Reference	Bankfull Area (ft²)	333	545.8	646	380.0	559.8	692.0	552.8
	Width/Depth Ratio	43.1	48	57.6	50.2	69.1	85.3	58.6
	Mean Depth (ft)	2.78	3.335	3.74	2.1	2.8	3.4	3.1
	Max Depth (ft)	4.33	4.67	4.94	4.50	5.17	6.04	4.92
	Width (ft)	119.8	160.4	192.9	170.0	189.4	201.2	174.9

Channel Cross-section Dimensionless Ratios

2004 Data

Dimensionless Metric	Min	Mean	Max
Wfpa / Wbkf	1.25	1.88	3.00
Abkf	465.44	512.89	598.97
Dmbkf	3.86	5.31	6.23
Dbkf	3.00	3.39	4.34
Wbkf	137.96	152.63	182.60
Pool Area / Abkf	0.96	1.19	1.57
Max Pool Depth / Dbkf	1.37	1.90	2.32
Mean Pool Depth / Dbkf	0.86	1.10	1.40
Pool Width / Wbkf	0.92	1.08	1.21
Run Area / Abkf	0.75	0.98	1.20
Max Run Depth / Dbkf	1.10	1.82	2.31
Mean Run Depth / Dbkf	0.90	1.00	1.09
Run Width / Wbkf	0.82	0.96	1.10
Glide Area / Abkf	0.65	1.06	1.26
Max Glide Depth / Dbkf	1.28	1.38	1.46
Mean Glide Depth / Dbkf	0.82	0.96	1.08
Glide Width / Wbkf	0.78	1.08	1.34

2006 Data

Dimensionless Metric	Min	Mean	Max
Wfpa / Wbkf	1.65	2.49	3.45
Abkf	423.08	505.59	605.94
Dmbkf	4.08	4.95	5.75
Dbkf	2.71	3.50	4.21
Wbkf	120.99	146.92	195.00

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00350	0.00520	0.00597
S pool (ft/ft)	0.00030	0.00042	0.00044
S run (ft/ft)	0.0023	0.0023	0.0023
S glide (ft/ft)	0.00070	0.00106	0.00158
P - P (ft)	1037.70	1485.93	1934.06
P length (ft)	176.90	261.41	406.86
Dmax riffle (ft)	4.16	5.02	5.61
Dmax pool (ft)	6.43	7.13	7.57
Dmax run (ft)	5.80	6.39	7.06
Dmax glide (ft)	4.67	4.90	5.11
Low Bank Ht (ft)	3.53	3.75	3.97
Bankfull Slope (ft/ft)		0.00269	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.33	1.93	2.22
S pool / S bkf (ft/ft)	0.14	0.16	0.16
S run / S bkf (ft/ft)	0.85	0.85	0.85
S glide / S bkf (ft/ft)	0.29	0.39	0.59
P - P / W bkf (ft)	6.80	9.74	12.67
P length / W bkf (ft)	1.16	1.71	2.67
Dmax riffle / D bkf (ft)	1.23	1.48	1.65
Dmax pool / D bkf (ft)	1.90	2.10	2.23
Dmax run / D bkf (ft)	1.71	1.88	2.08
Dmax glide / D bkf (ft)	1.38	1.45	1.51
Low Bank Ht / Dmax riff (ft)	0.70	0.75	0.79
Bankfull Slope (ft/ft)		0.00269	

2006 Data

Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00487	0.00517	0.00547
S pool (ft/ft)	0.00029	0.00087	0.00135
S run (ft/ft)	0.00283	0.00576	0.00947
S glide (ft/ft)	0.00072	0.00118	0.00194
P - P (ft)	674.05	1290.45	1861.11
P length (ft)	131.23	194.86	256.50
Dmax riffle (ft)	3.03	4.57	5.71
Dmax pool (ft)	7.10	7.30	7.50
Dmax run (ft)	5.98	6.48	6.96
Dmax glide (ft)	4.01	5.48	6.53
Low Bank Ht (ft)	3.25	3.85	4.45
Bankfull Slope (ft/ft)		0.00275	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.77	1.88	1.99
S pool / S bkf (ft/ft)	0.11	0.32	0.49
S run / S bkf (ft/ft)	1.03	2.09	3.44
S glide / S bkf (ft/ft)	0.26	0.43	0.71
P - P / W bkf (ft)	4.59	8.78	12.67
P length / W bkf (ft)	0.89	1.33	1.75
Dmax riffle / D bkf (ft)	0.87	1.31	1.63
Dmax pool / D bkf (ft)	2.03	2.09	2.14
Dmax run / D bkf (ft)	1.71	1.85	1.99
Dmax glide / D bkf (ft)	1.15	1.57	1.87
Low Bank Ht / Dmax riff (ft)	0.71	0.84	0.97
Bankfull Slope (ft/ft)		0.00275	

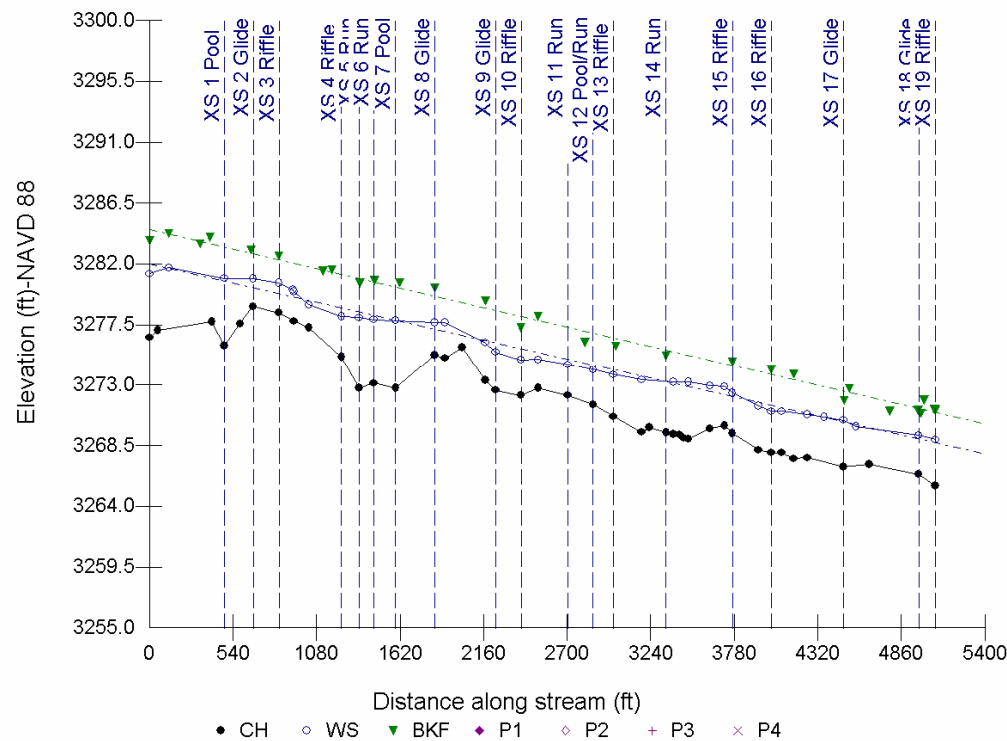
Channel Planform Dimensions and Dimensionless Ratios

Year	Planform Metric			
	Meander Length (ft)	Radius of Curvature (ft)	Belt Width (ft)	Sinuosity (ft/ft)
1937	1475	606	1264	1.35
1956	1615	900	414	1.91
1966	1700	650	522	1.28
2000	2150	727	572	1.17
2005	2138	838	608	1.23

Year	Planform Dimensionless Ratios [^]			
	Meander Length / Wbkf	Radius of Curvature / Wbkf	Belt Width / Wbkf	Sinuosity (ft/ft)
1937	10.10	4.15	8.66	1.35
1956	11.06	6.16	2.84	1.91
1966	11.64	4.45	3.58	1.28
2000	14.73	4.98	3.92	1.17
2005	14.64	5.74	4.16	1.23

[^]: An average riffle width of 147 ft measured in the August 2006 survey was used to develop the dimensionless ratios.

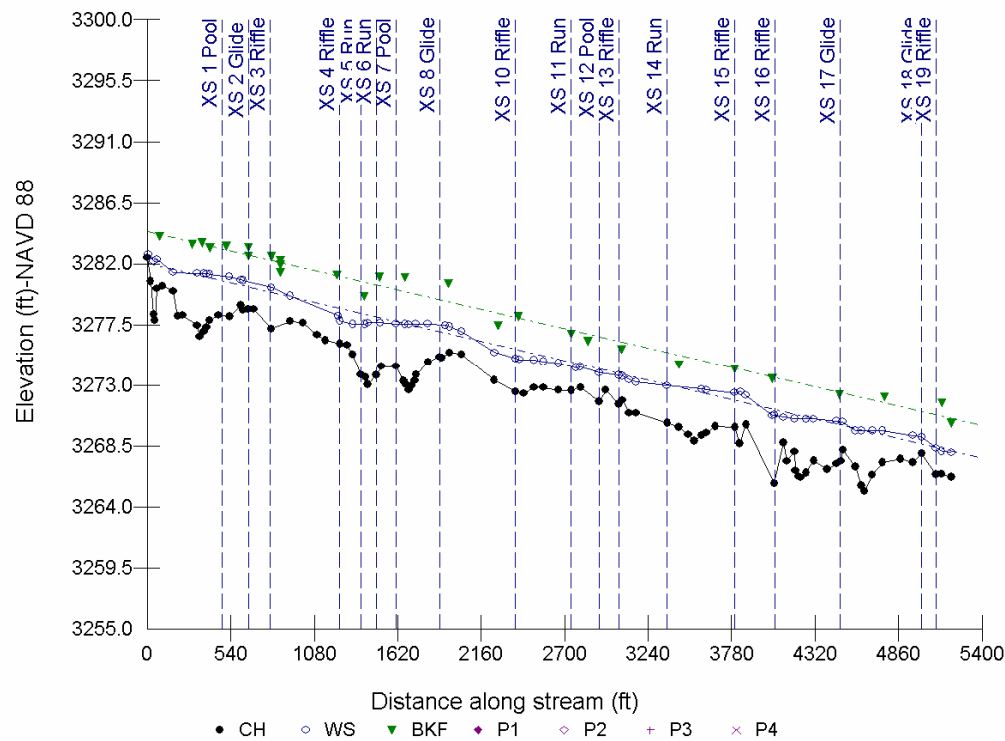
CFR 3B 2004



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00350	0.00520	0.00597
S pool (ft/ft)	0.00030	0.00042	0.00044
S run (ft/ft)	0.00060	0.00110	0.00148
S glide (ft/ft)	0.00070	0.00106	0.00158
P - P (ft)	1037.70	1485.93	1934.06
P length (ft)	176.90	261.41	406.86
Dmax riffle (ft)	4.16	5.02	5.61
Dmax pool (ft)	6.43	7.13	7.57
Dmax run (ft)	5.80	6.39	7.06
Dmax glide (ft)	4.67	4.90	5.11
Low Bank Ht (ft)	3.53	3.75	3.97
Bankfull Slope (ft/ft)		0.00269	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.33	1.93	2.22
S pool / S bkf (ft/ft)	0.14	0.16	0.16
S run / S bkf (ft/ft)	0.24	0.41	0.55
S glide / S bkf (ft/ft)	0.29	0.39	0.59
P - P / W bkf (ft)	6.80	9.74	12.67
P length / W bkf (ft)	1.16	1.71	2.67
Dmax riffle / D bkf (ft)	1.23	1.48	1.65
Dmax pool / D bkf (ft)	1.90	2.10	2.23
Dmax run / D bkf (ft)	1.71	1.88	2.08
Dmax glide / D bkf (ft)	1.38	1.45	1.51
Low Bank Ht / Dmax riff (ft)	0.70	0.75	0.79
Bankfull Slope (ft/ft)		0.00269	

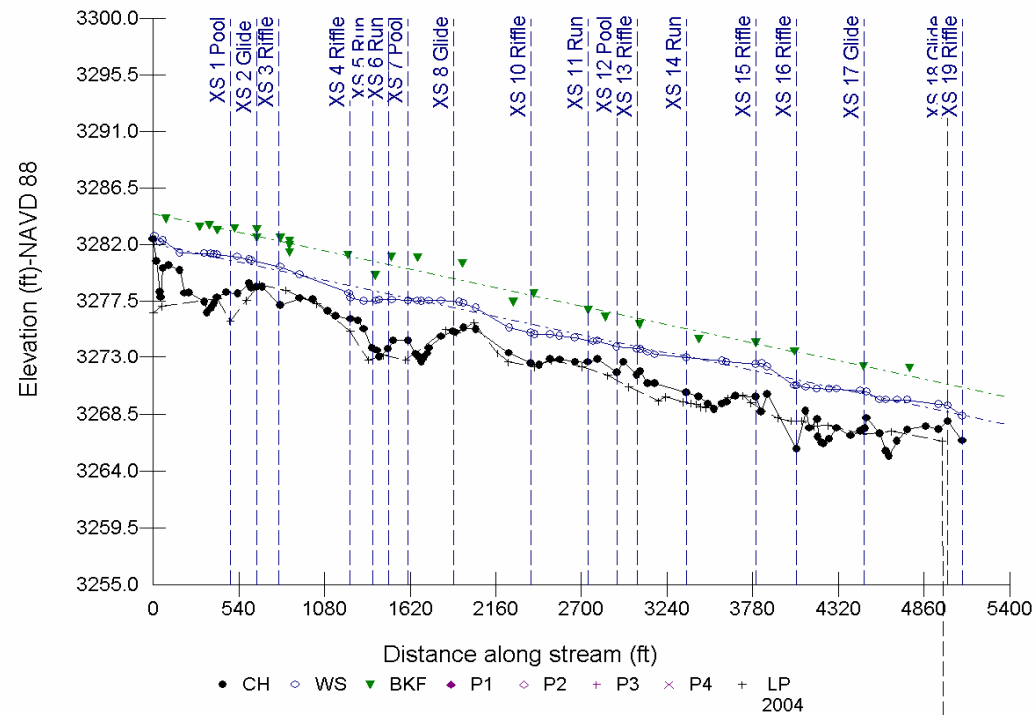
CFR 3B 2006



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00098	0.00321	0.00477
S pool (ft/ft)	0.00029	0.00087	0.00135
S run (ft/ft)	0.00283	0.00576	0.00947
S glide (ft/ft)	0.00072	0.00118	0.00194
P - P (ft)	674.05	1290.45	1861.11
P length (ft)	131.23	194.86	256.50
Dmax riffle (ft)	3.03	4.57	5.71
Dmax pool (ft)	7.10	7.30	7.50
Dmax run (ft)	5.98	6.48	6.96
Dmax glide (ft)	4.01	5.48	6.53
Low Bank Ht (ft)	3.25	3.85	4.45
Bankfull Slope (ft/ft)		0.00275	

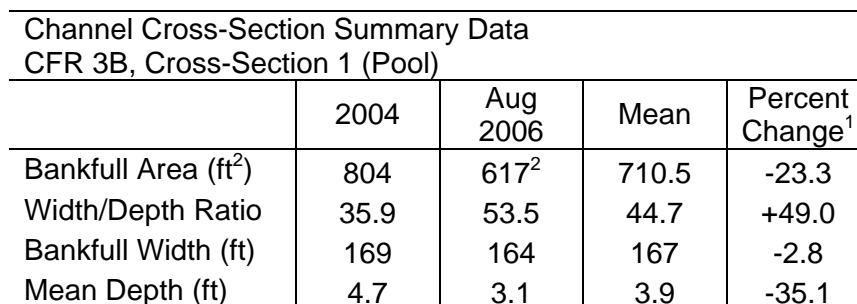
Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.36	1.17	1.73
S pool / S bkf (ft/ft)	0.11	0.32	0.49
S run / S bkf (ft/ft)	1.03	2.09	3.44
S glide / S bkf (ft/ft)	0.26	0.43	0.71
P - P / W bkf (ft)	4.59	8.78	12.67
P length / W bkf (ft)	0.89	1.33	1.75
Dmax riffle / D bkf (ft)	0.87	1.31	1.63
Dmax pool / D bkf (ft)	2.03	2.09	2.14
Dmax run / D bkf (ft)	1.71	1.85	1.99
Dmax glide / D bkf (ft)	1.15	1.57	1.87
Low Bank Ht / Dmax riff (ft)	0.71	0.84	0.97
Bankfull Slope (ft/ft)		0.00275	

CFR 3B 2004 and 2006

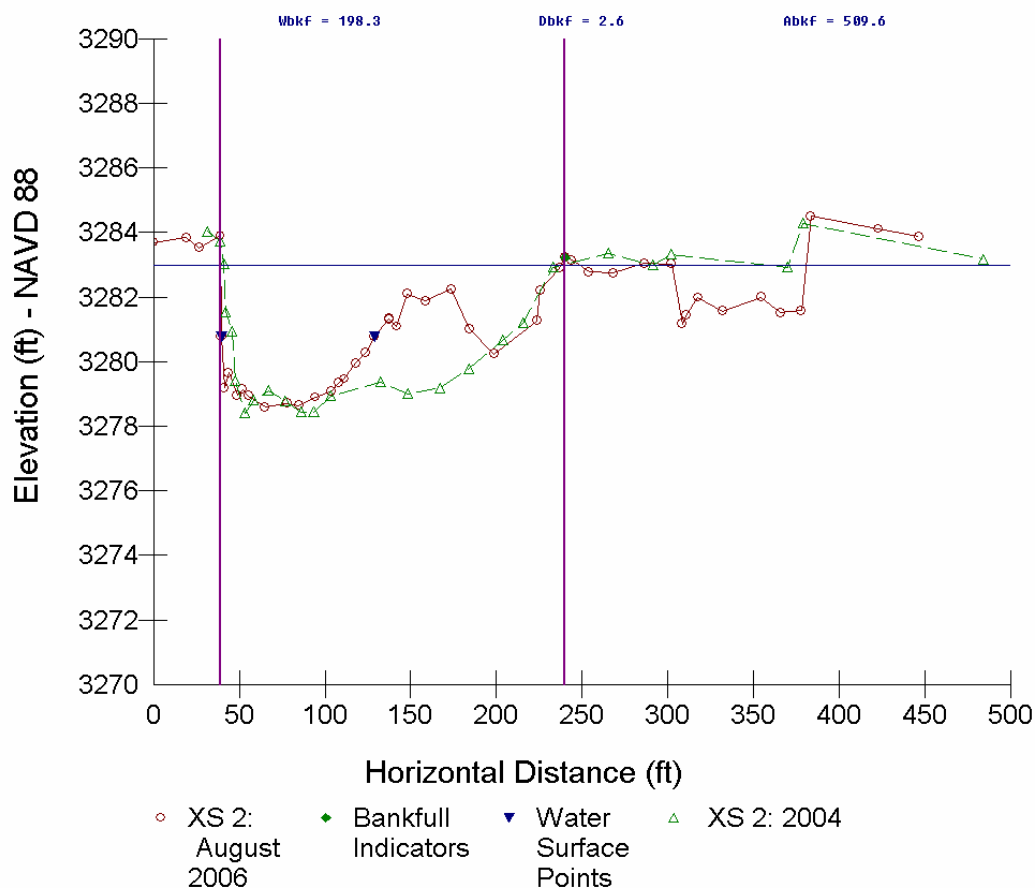


Profile Dimensions	2004	2006	Difference
Metric	Mean	Mean	(+/-)
S riffle (ft/ft)	0.00520	0.00321	-0.00199
S pool (ft/ft)	0.00042	0.00087	0.00045
S run (ft/ft)	0.00110	0.00576	0.00466
S glide (ft/ft)	0.00106	0.00118	0.00012
P - P (ft)	1485.93	1290.45	-195.48
P length (ft)	261.41	194.86	-66.55
Dmax riffle (ft)	5.02	4.57	-0.45
Dmax pool (ft)	7.13	7.30	0.17
Dmax run (ft)	6.39	6.48	0.09
Dmax glide (ft)	4.90	5.48	0.58
Low Bank Ht (ft)	3.75	3.85	0.10
Bankfull Slope (ft/ft)	0.00269	0.00275	0.00006

Profile Dimensionless	2004	2006	Difference
Metric	Mean	Mean	(+/-)
S riffle / S bkf (ft/ft)	1.93	1.17	-0.77
S pool / S bkf (ft/ft)	0.16	0.32	0.16
S run / S bkf (ft/ft)	0.41	2.09	1.69
S glide / S bkf (ft/ft)	0.39	0.43	0.04
P - P / W bkf (ft)	9.74	8.78	-0.95
P length / W bkf (ft)	1.71	1.33	-0.39
Dmax riffle / D bkf (ft)	1.48	1.31	-0.18
Dmax pool / D bkf (ft)	2.10	2.09	-0.02
Dmax run / D bkf (ft)	1.88	1.85	-0.03
Dmax glide / D bkf (ft)	1.45	1.57	0.12
Low Bank Ht / Dmax riff (ft)	0.75	0.84	0.10
Bankfull Slope (ft/ft)	0.00269	0.00275	0.00

Channel Unit: Pool

²Includes overbank side channel area

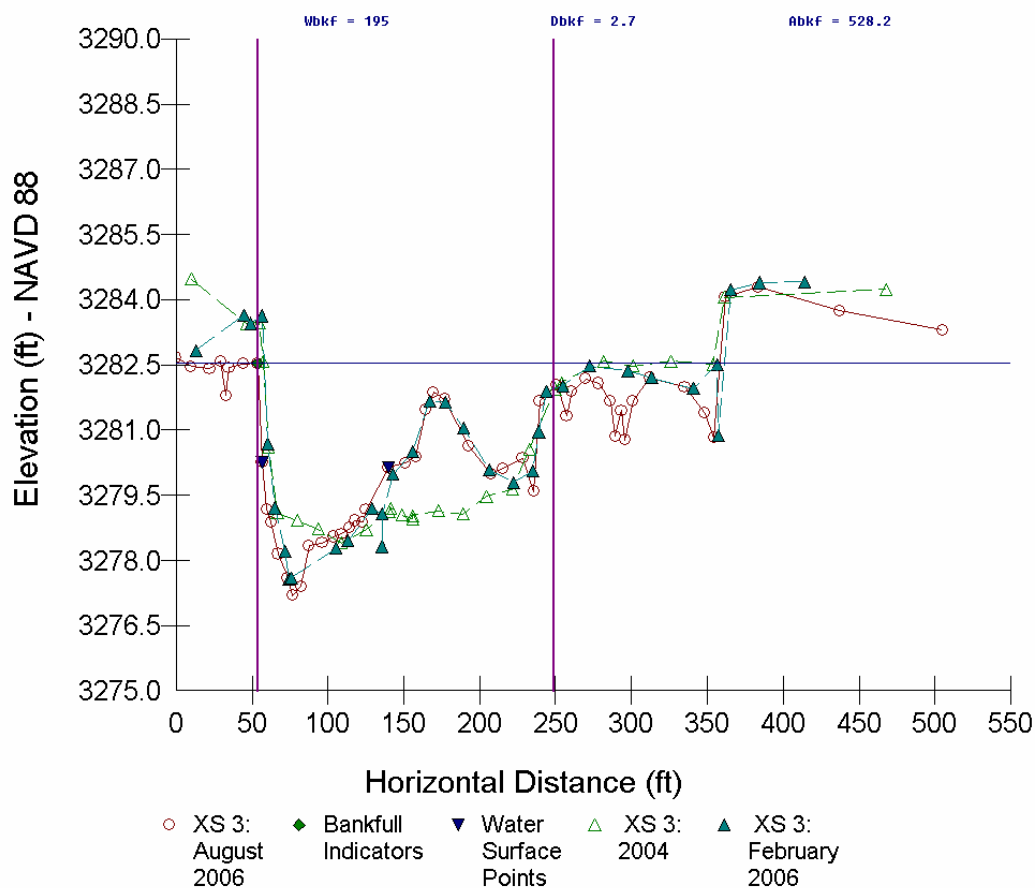
Reach: **CFR 3B**Cross-Section: **2**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 2 (Glide)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	646	677 ²	661.5	4.8
Width/Depth Ratio	57.6	71.7	64.7	+24.5
Bankfull Width (ft)	193	201	197	4.1
Mean Depth (ft)	3.4	2.8	3.1	-16.4

¹ Change from 2004 to 2006

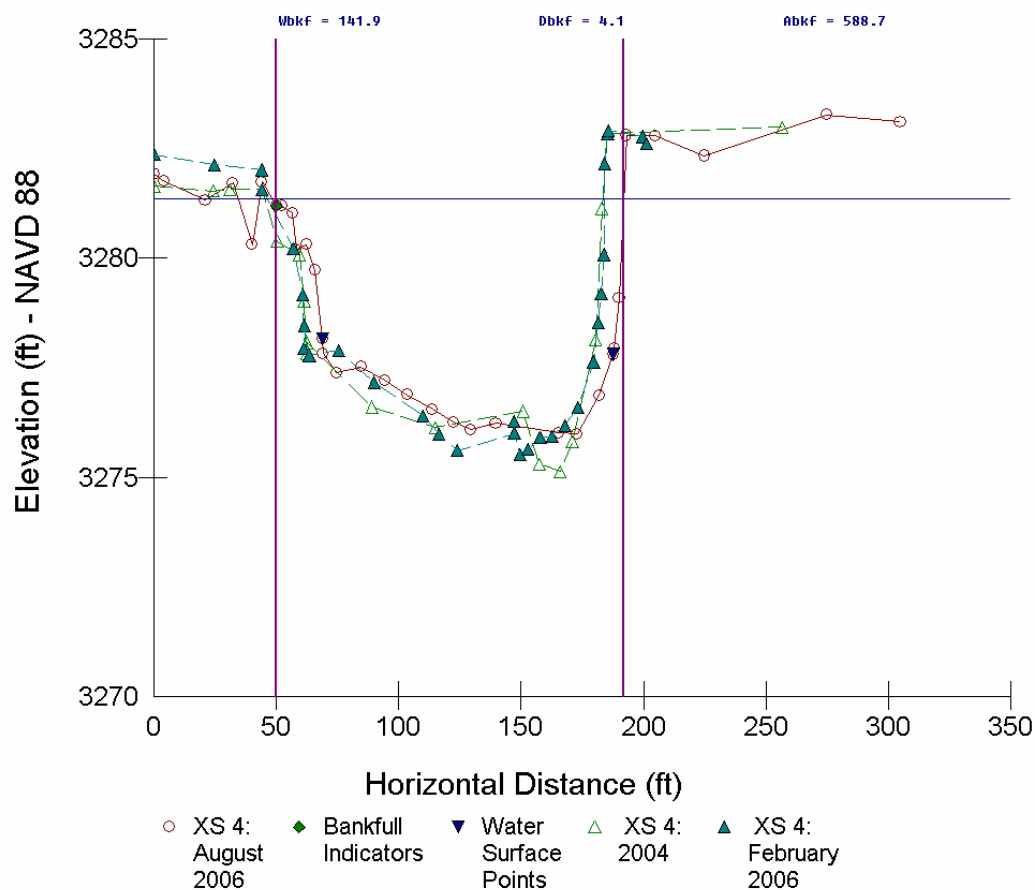
² Includes overbank side channel area

Reach: **CFR 3B**Cross-Section: **3**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 3 (Glide)

	2004	Feb 2006	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	563	524	476	521	-15.5
Width/Depth Ratio	65.7	85.8	79.9	77.1	+21.6
Bankfull Width (ft)	192	212	195	200	+1.4
Mean Depth (ft)	2.9	2.5	2.4	2.6	-16.7

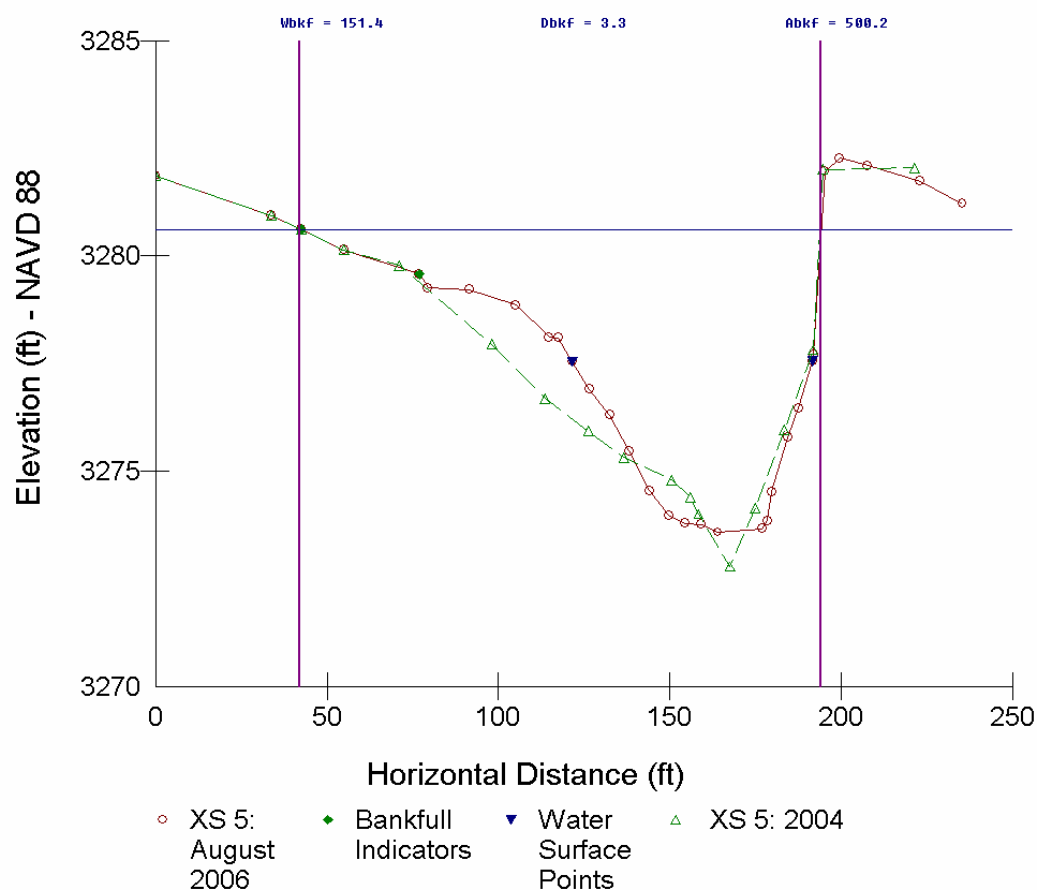
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **4**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 4 (Riffle)

	2004	Feb 2006	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	599	593	589	594	-1.7
Width/Depth Ratio	31.8	32.0	34.2	32.7	+7.5
Bankfull Width (ft)	138	138	142	139	+2.8
Mean Depth (ft)	4.3	4.3	4.2	4.3	-4.4

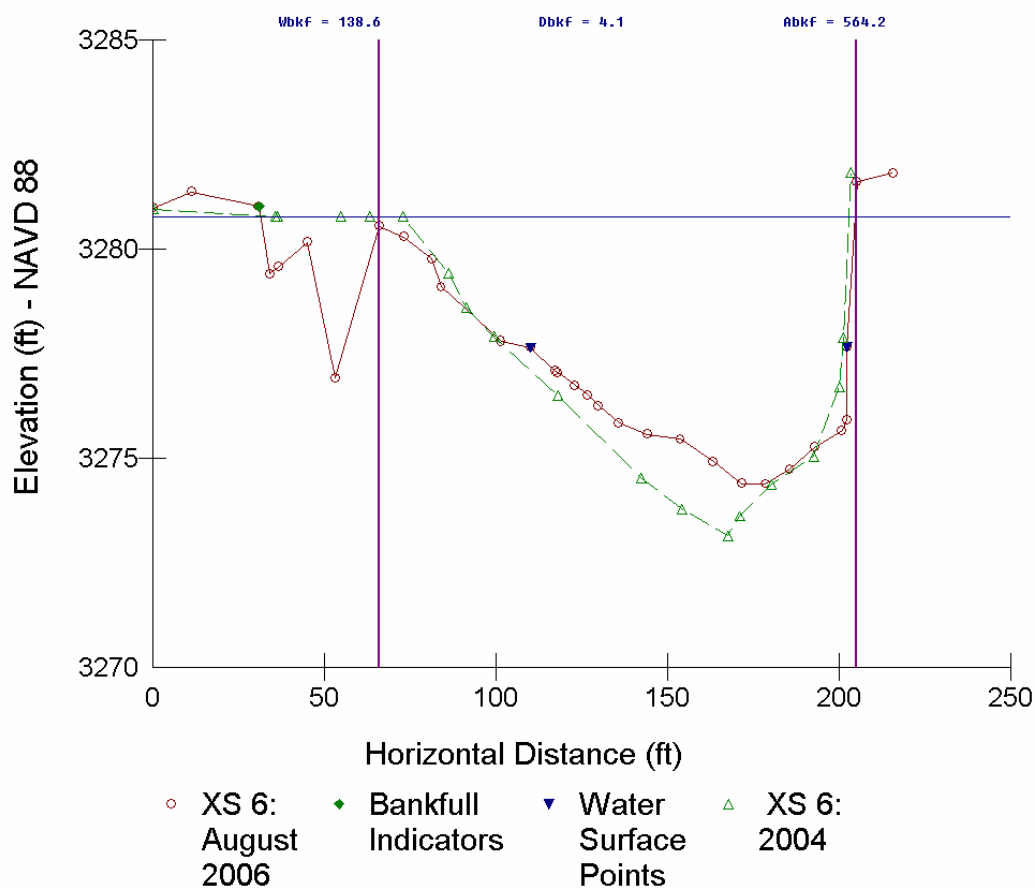
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **5**Channel Unit: **Run**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 5 (Run)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	542	500	521	-7.7
Width/Depth Ratio	41.9	45.9	43.9	+9.5
Bankfull Width (ft)	151	151	151	0.0
Mean Depth (ft)	3.6	3.3	3.4	-8.3

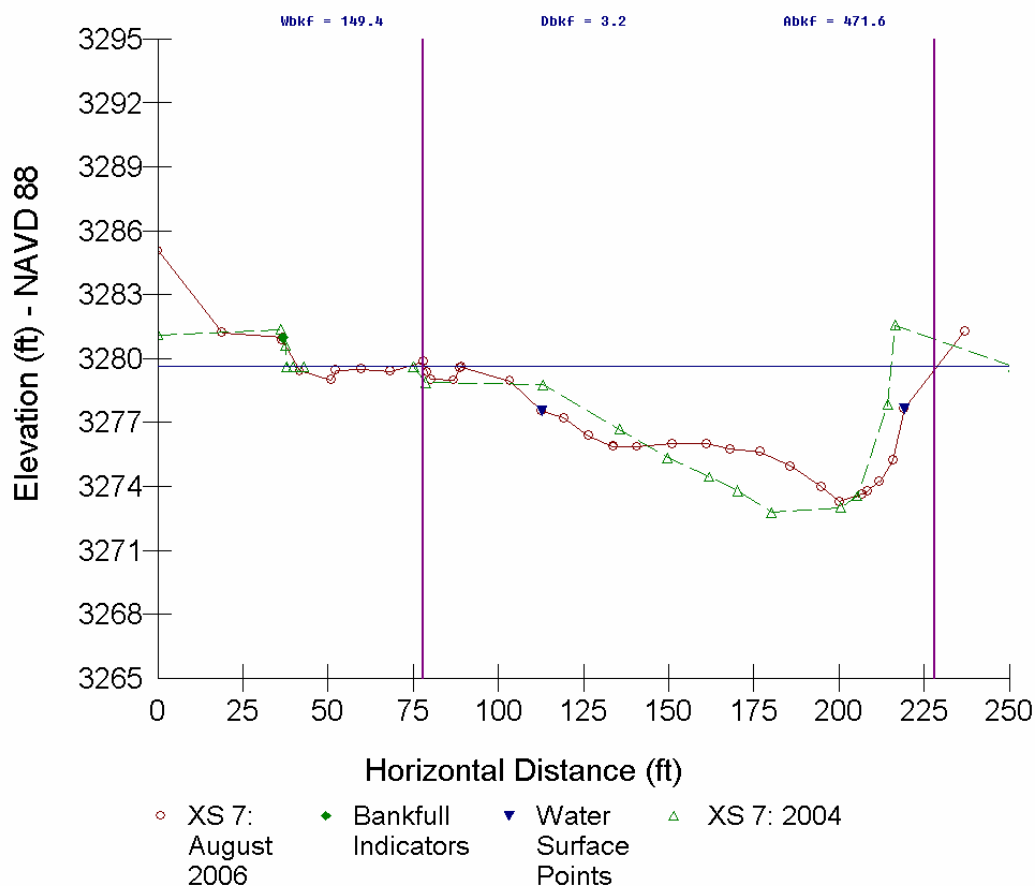
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **6**Channel Unit: **Run**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 6 (Run)

	2004	Aug 2006	Mean	Percent Change
Bankfull Area (ft ²)	616	564	590	-8.4
Width/Depth Ratio	27.3	34.1	30.7	+24.9
Bankfull Width (ft)	130	139	135	+6.9
Mean Depth (ft)	4.8	4.1	4.4	-14.3

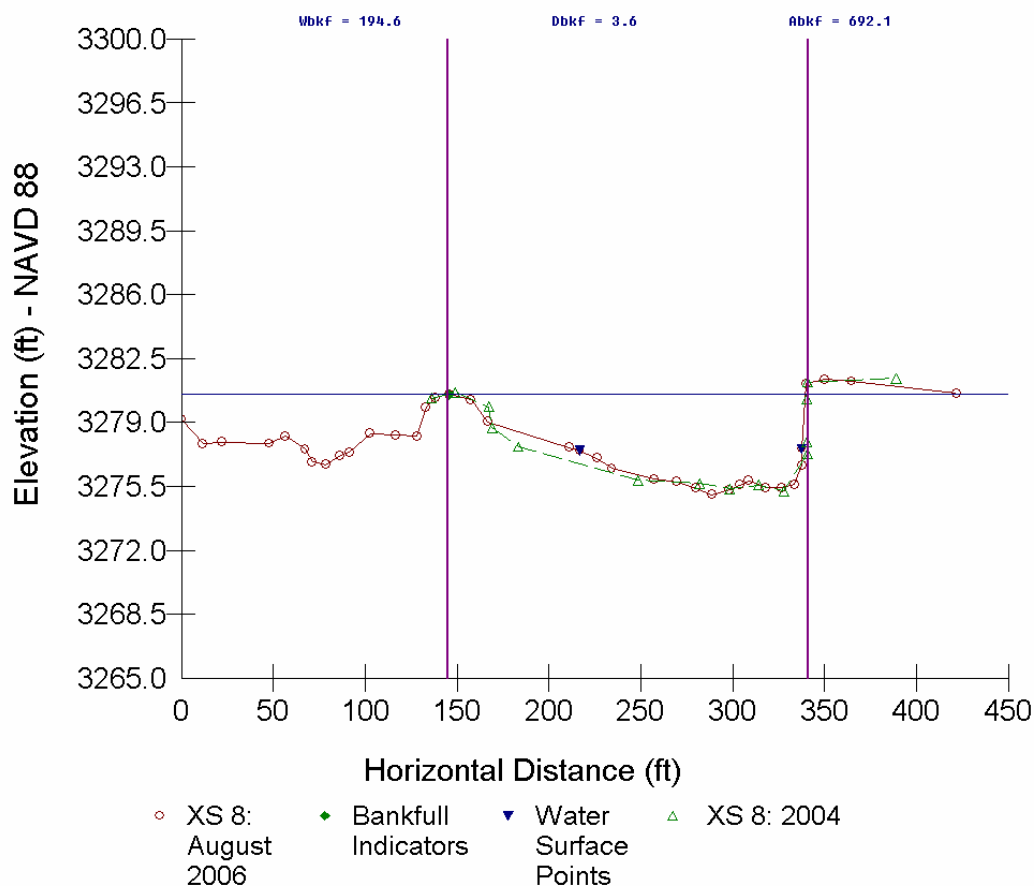
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **7**Channel Unit: **Pool**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 7 (Pool)

	2004	Aug 2006	Mean	Percent Change
Bankfull Area (ft ²)	492	472	482	-4.1
Width/Depth Ratio	40.0	47.3	43.7	+18.3
Bankfull Width (ft)	140	149	146	+6.4
Mean Depth (ft)	3.5	3.2	3.3	-10.0

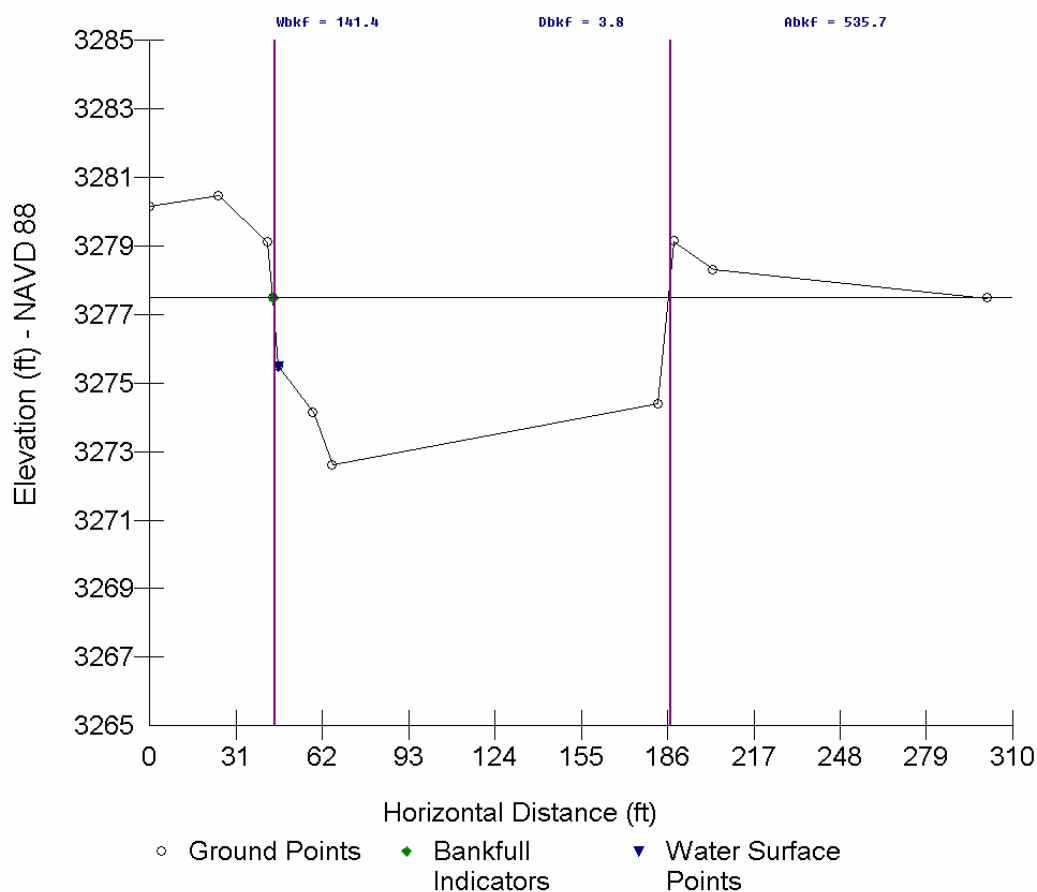
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **8**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 8 (Glide)

	2004	Aug 2006	Mean	Percent Change
Bankfull Area (ft ²)	646	692	669	+7.1
Width/Depth Ratio	46.3	58.5	50.5	+26.3
Bankfull Width (ft)	173	201	184	+16.3
Mean Depth (ft)	3.7	3.4	3.7	-8.0

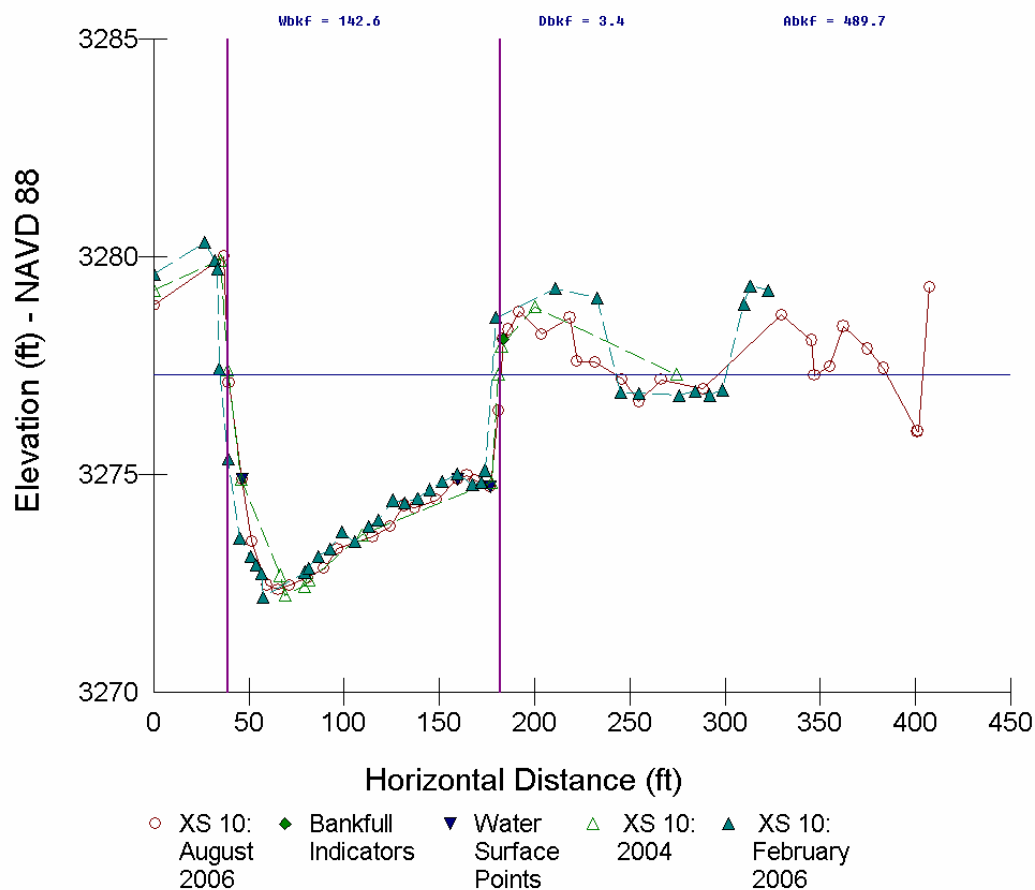
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **9**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 9 (Riffle)

	2004	Aug 2006	Mean	Percent Change
Bankfull Area (ft ²)	536	n/a	536	n/a
Width/Depth Ratio	37.3	n/a	37.3	n/a
Bankfull Width (ft)	141	n/a	141	n/a
Mean Depth (ft)	3.8	n/a	3.8	n/a

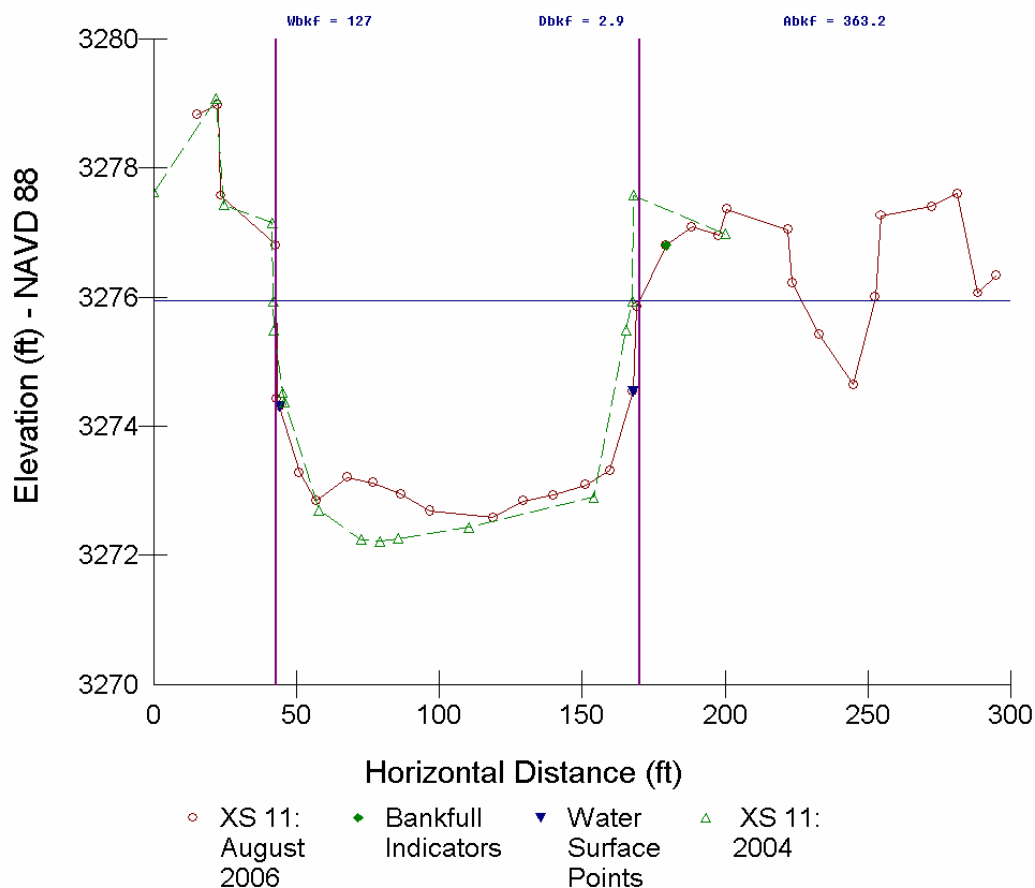
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **10**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 10 (Riffle)

	2004	Feb 2005	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	486	482	490	486	+0.8
Width/Depth Ratio	41.5	42.4	41.6	41.8	+0.2
Bankfull Width (ft)	142	143	143	142	+0.7
Mean Depth (ft)	3.4	3.4	3.4	3.4	+0.0

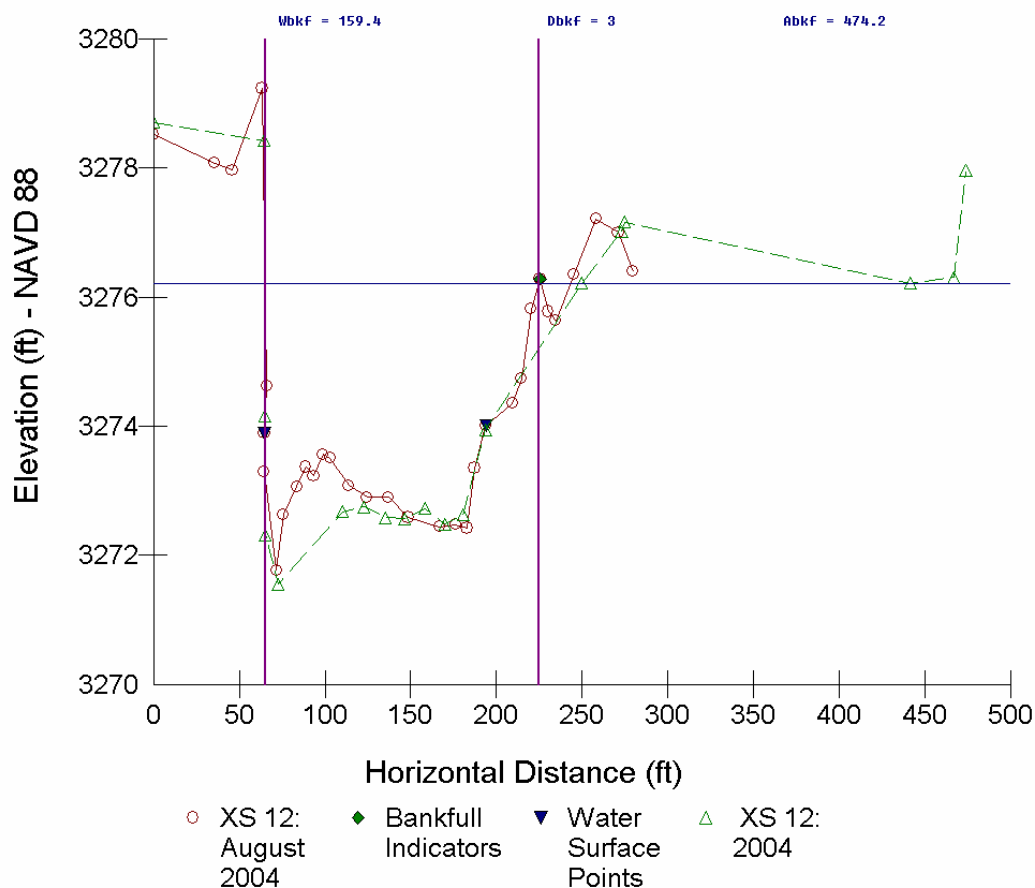
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **11**Channel Unit: **Run**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 11 (Run)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	384	363	374	-5.5
Width/Depth Ratio	41.0	44.4	42.7	+8.3
Bankfull Width (ft)	126	127	128	+1.2
Mean Depth (ft)	3.1	2.9	3.0	-6.5

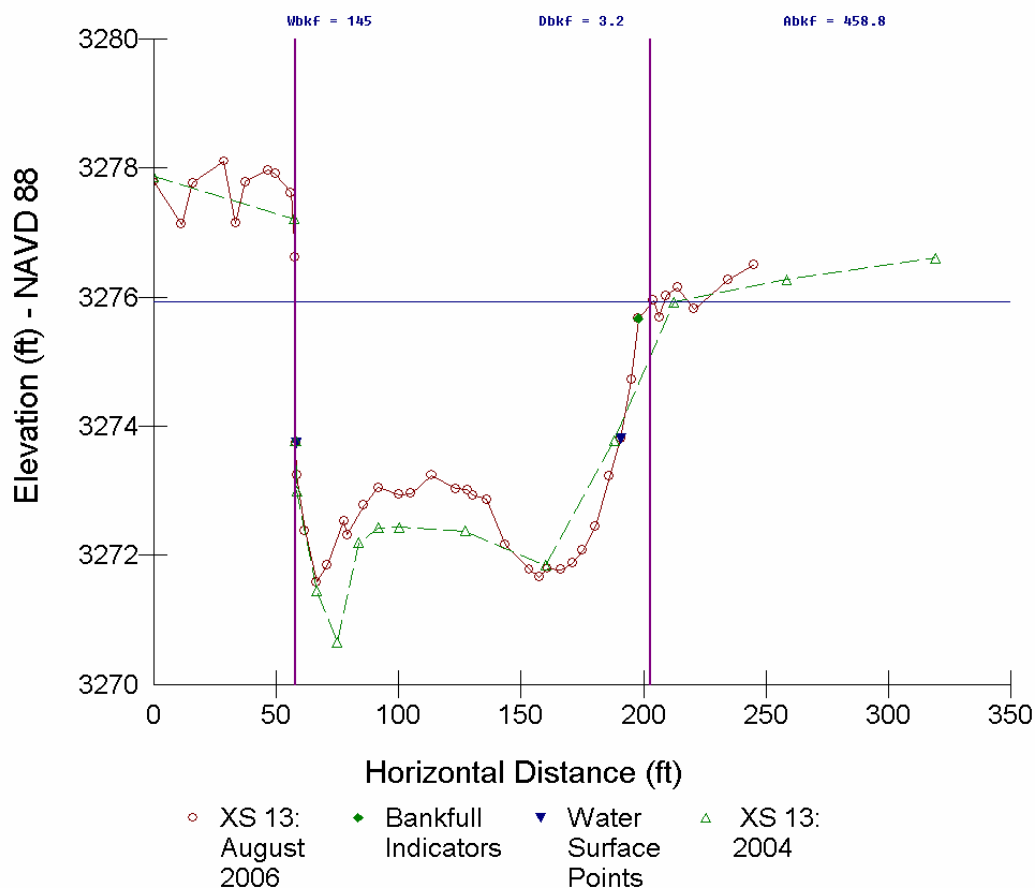
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **12**Channel Unit: **Pool**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 12 (Pool)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	536	474	505	-11.6
Width/Depth Ratio	62.5	53.5	58.0	-14.4
Bankfull Width (ft)	183	161	171	-12.9
Mean Depth (ft)	2.9	3.0	2.9	+1.7

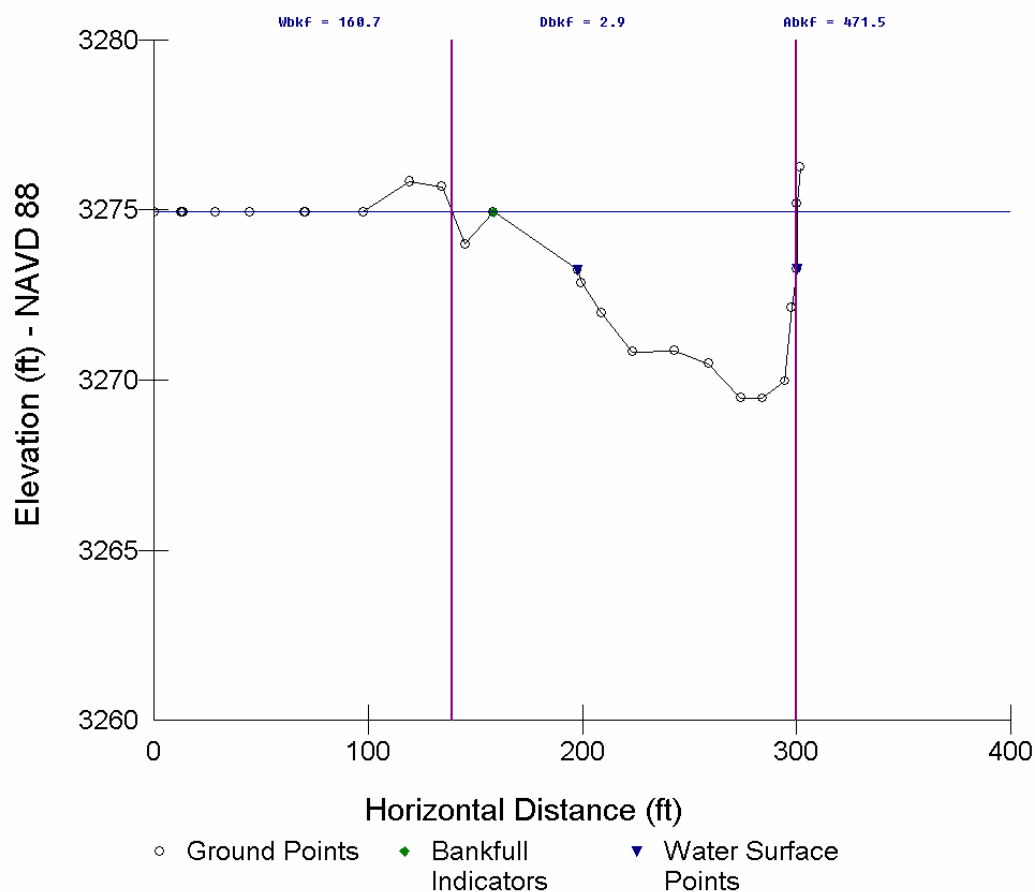
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **13**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 13 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	503	459	481	-8.7
Width/Depth Ratio	47.4	46.2	46.8	-2.5
Bankfull Width (ft)	155	145	150	-5.9
Mean Depth (ft)	3.3	3.2	3.25	-3.4

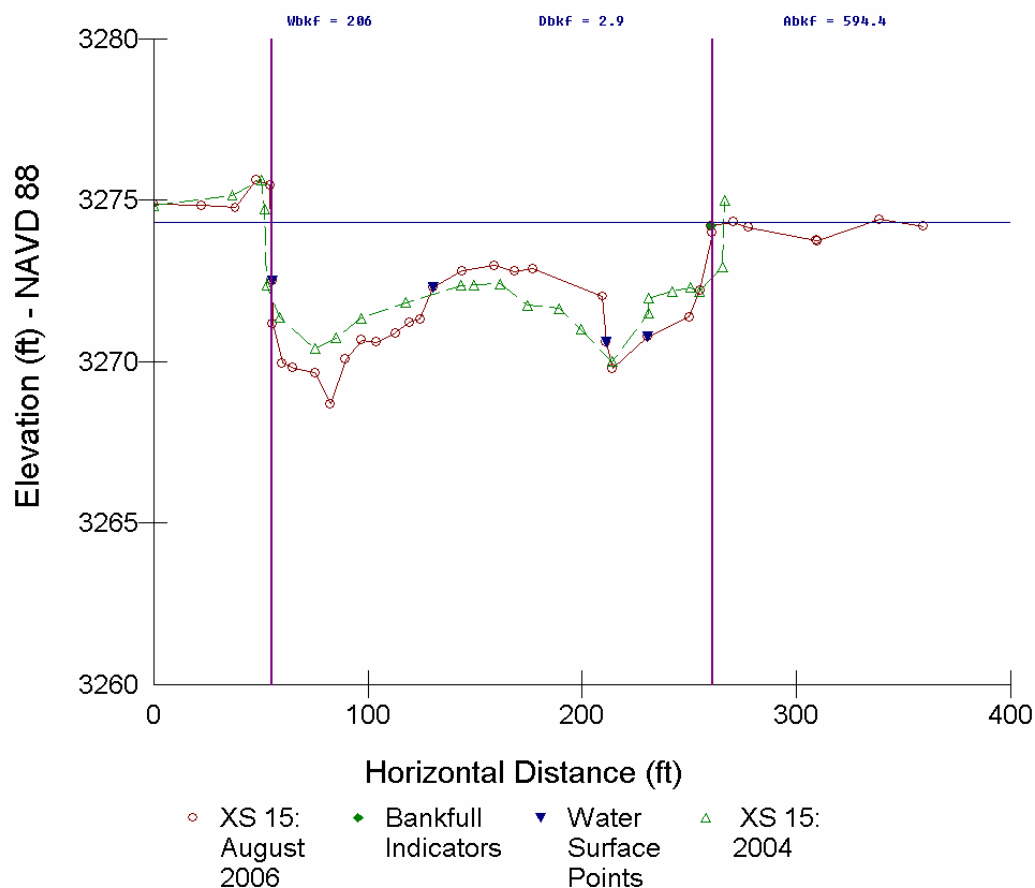
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **14**Channel Unit: **Run**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 14 (Run)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	472	n/a	472	n/a
Width/Depth Ratio	54.9	n/a	54.9	n/a
Bankfull Width (ft)	161	n/a	159	n/a
Mean Depth (ft)	2.9	n/a	2.9	n/a

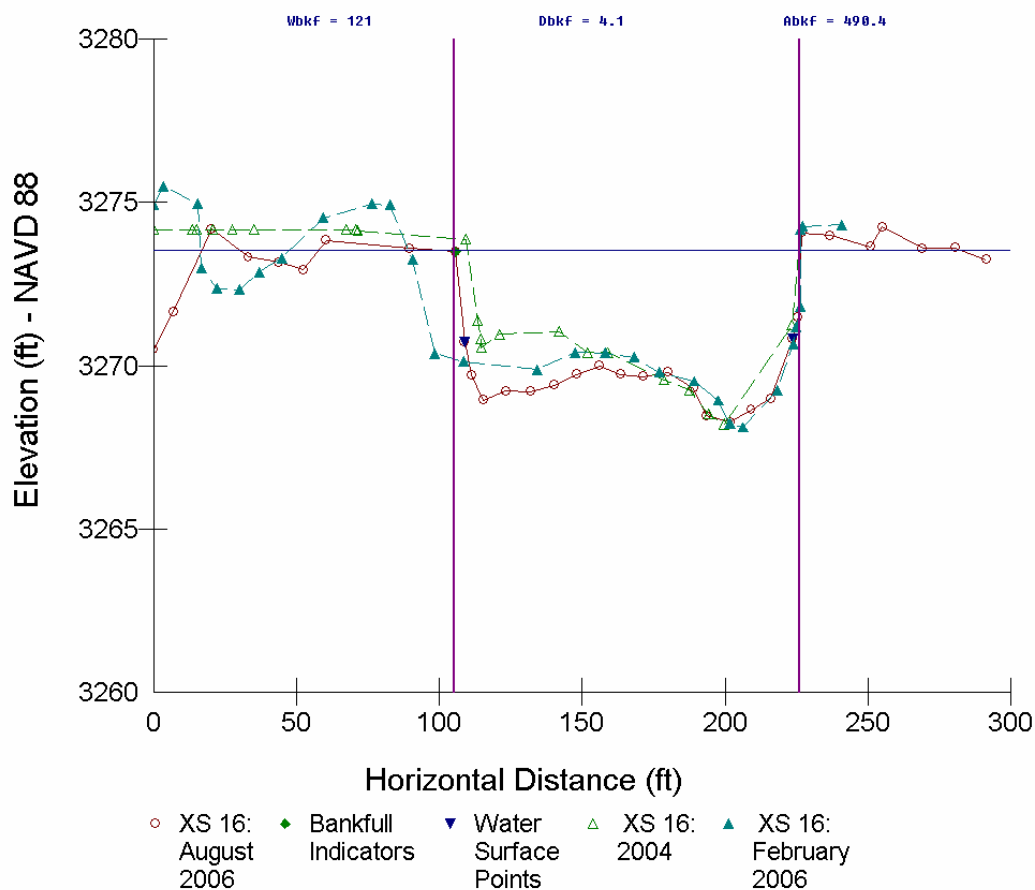
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **15**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 15 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	673	594	634	-11.7
Width/Depth Ratio	68.6	71.3	70.0	+3.9
Bankfull Width (ft)	215	206	210	-4.1
Mean Depth (ft)	3.1	2.9	3.0	-7.7

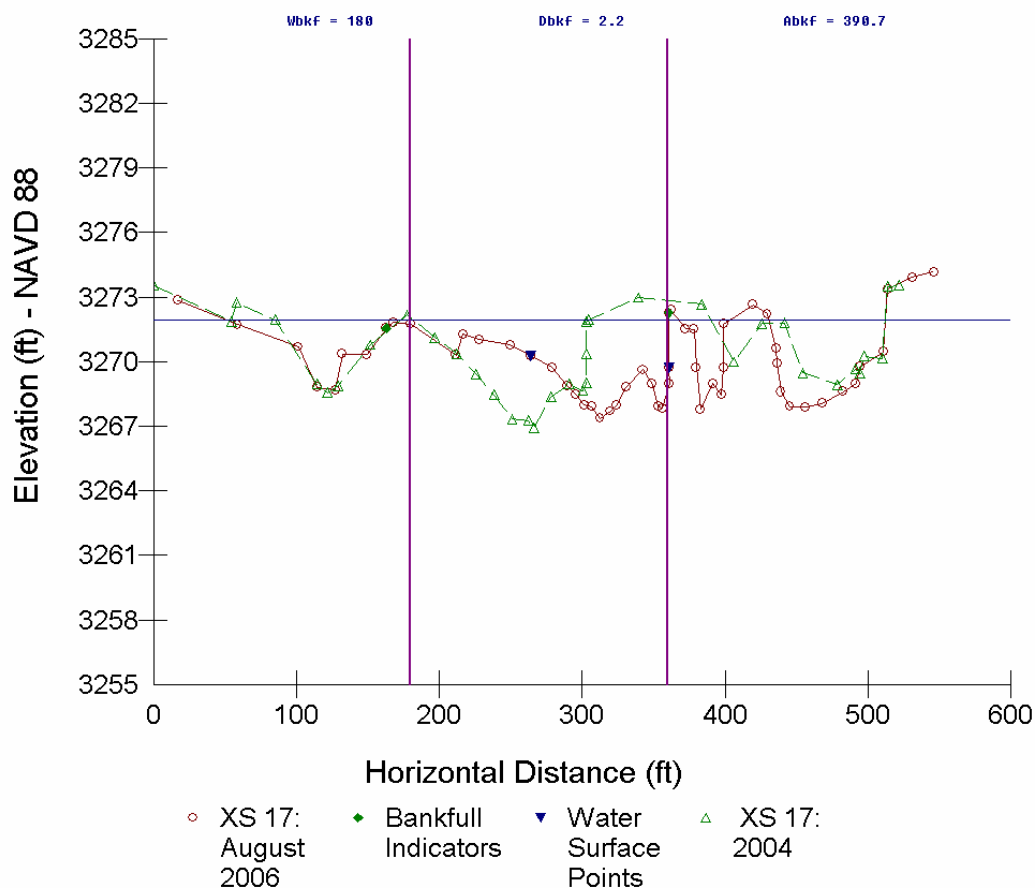
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **16**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 16 (Riffle)

	2004	Feb 2005	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	467	580	490	512	+4.9
Width/Depth Ratio	51.6	33.9	29.9	38.5	-42.1
Bankfull Width (ft)	155	140	121	139	-22.1
Mean Depth (ft)	3.0	4.1	4.1	3.7	+34.6

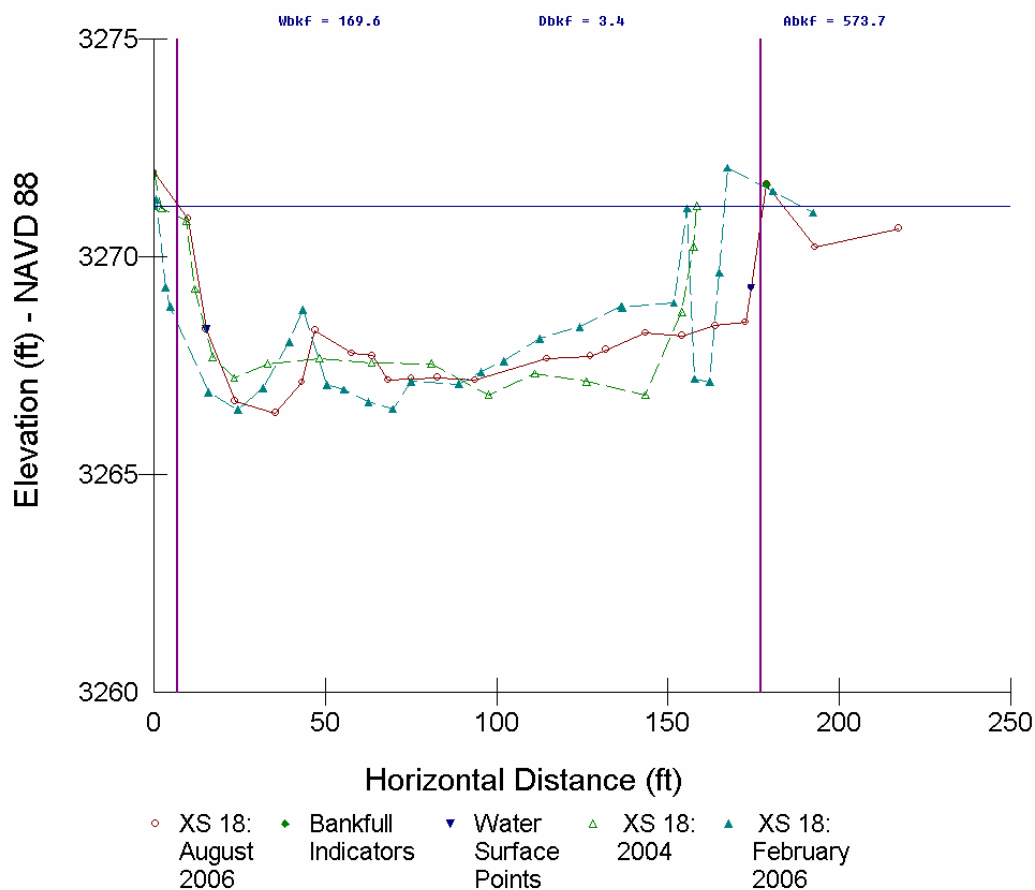
¹Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **17**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 17 (Glide)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	333	380	357	+14.1
Width/Depth Ratio	43.1	85.3	64.2	+97.9
Bankfull Width (ft)	120	180	150	+50.3
Mean Depth (ft)	2.8	2.1	2.5	-24.1

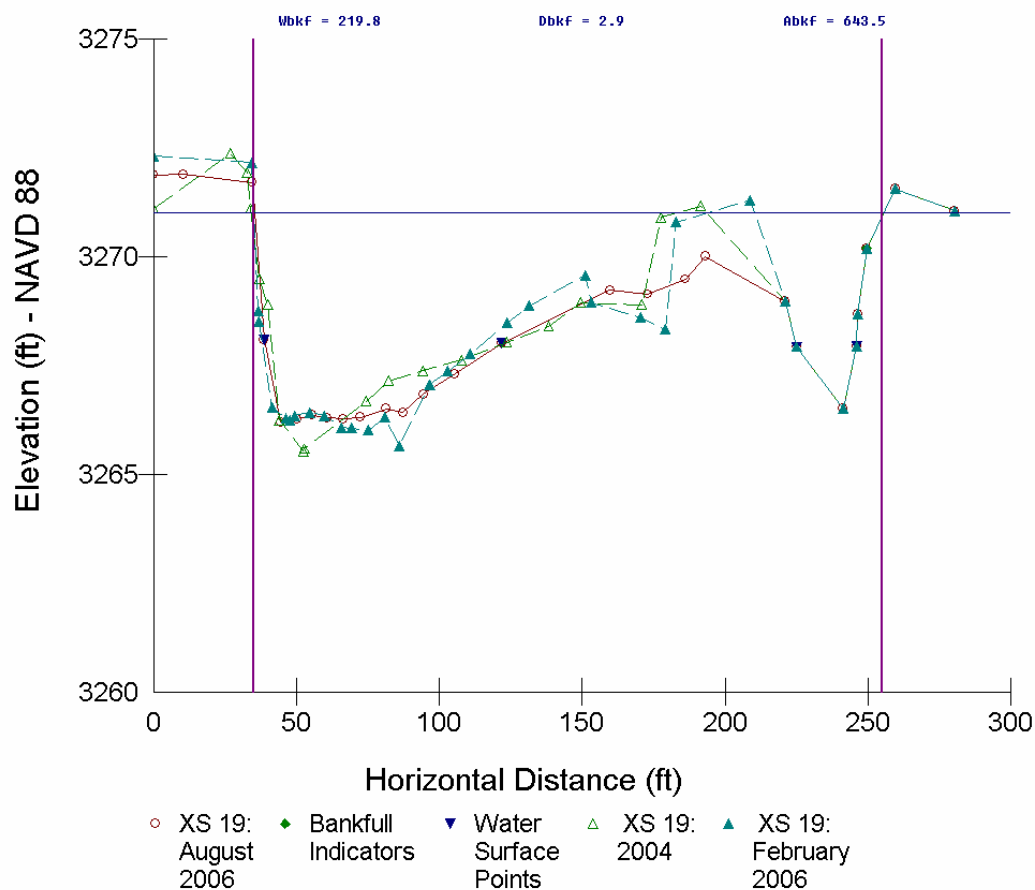
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **18**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 18 (Glide)

	2004	Feb 2005	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	541	556	574	557	+2.8
Width/Depth Ratio	45.0	49.2	50.2	48.1	+9.3
Bankfull Width (ft)	156	165	170	165	+5.9
Mean Depth (ft)	3.5	3.4	3.4	3.4	-3.2

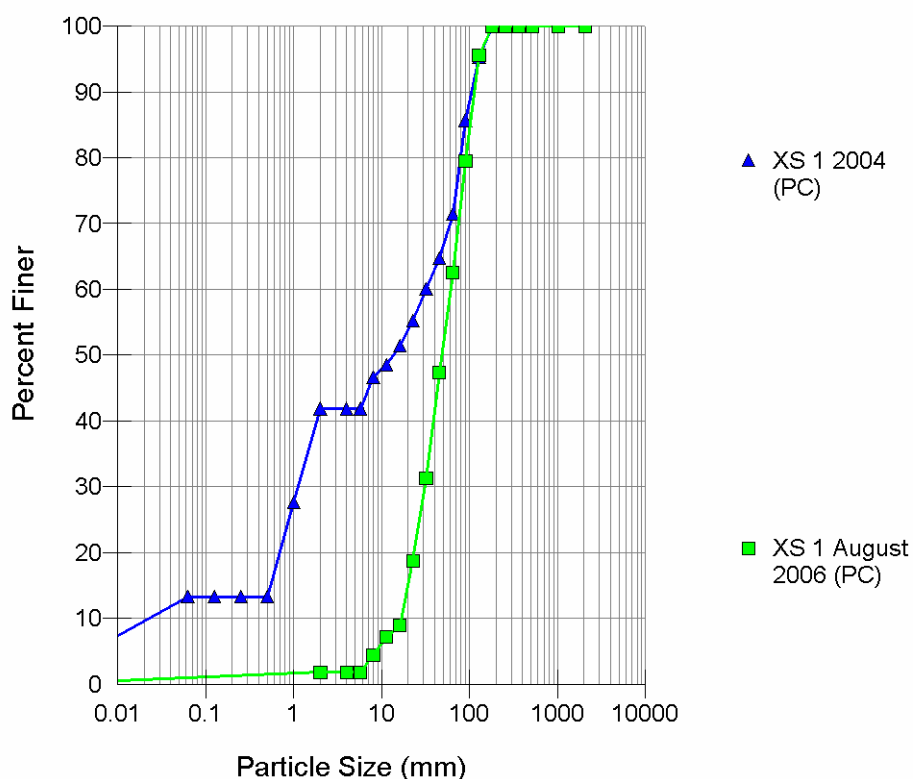
¹ Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **19**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3B, Cross-Section 19 (Riffle)

	2004	Feb 2005	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	486	492	643	540	+32.3
Width/Depth Ratio	42.2	44.4	75.0	53.9	+77.7
Bankfull Width (ft)	143	148	220	169	+53.8
Mean Depth (ft)	3.4	3.3	2.9	3.2	-13.6

¹Change from 2004 to 2006

Reach: **CFR 3B**Cross-Section: **1**Channel Unit: **Pool****Wolman Pebble Count****Wolman Pebble Count Results (mm)**

CFR 3B, Cross-Section 1 (Pool)

Size Class	2004	Feb 2006	Aug 2006	Mean
D16	<1	n/a	21	11
D35	2	n/a	35	18
D50	14	n/a	48	31
D84	87	n/a	101	94
D95	127	n/a	127	127
D100	180	n/a	180	180

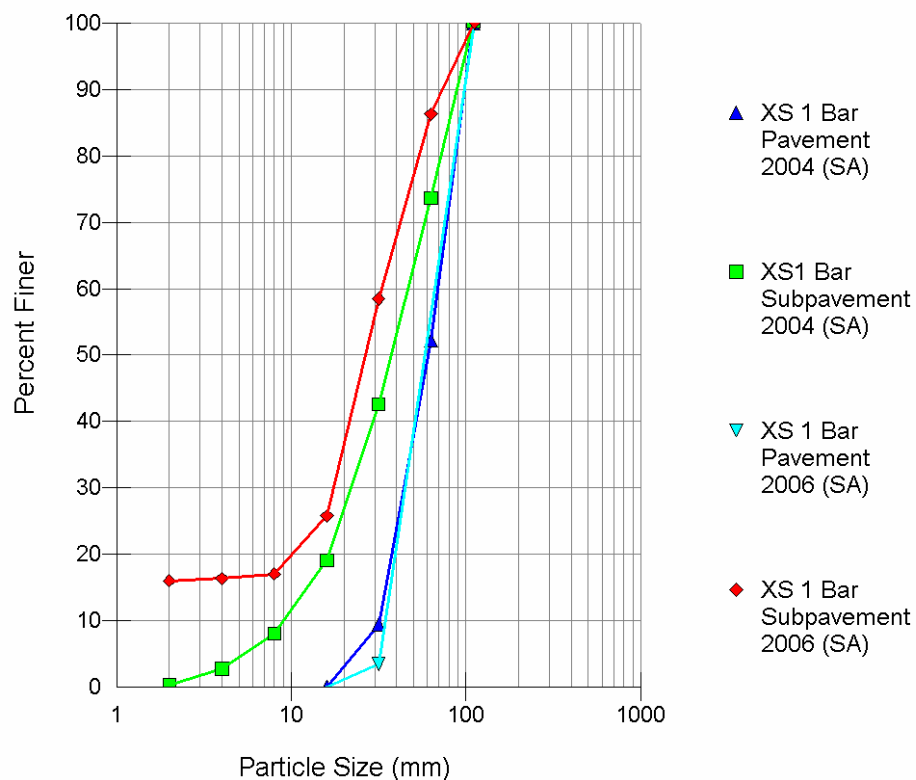
Riffle Stability Index (RSI) Results (mm)

CFR 3B, Cross-Section 1 (Pool)

2004			2006		
Max ¹	Mean ²	RSI Score ³	Max	Mean	RSI Score
270	176	D96	156	126	D85

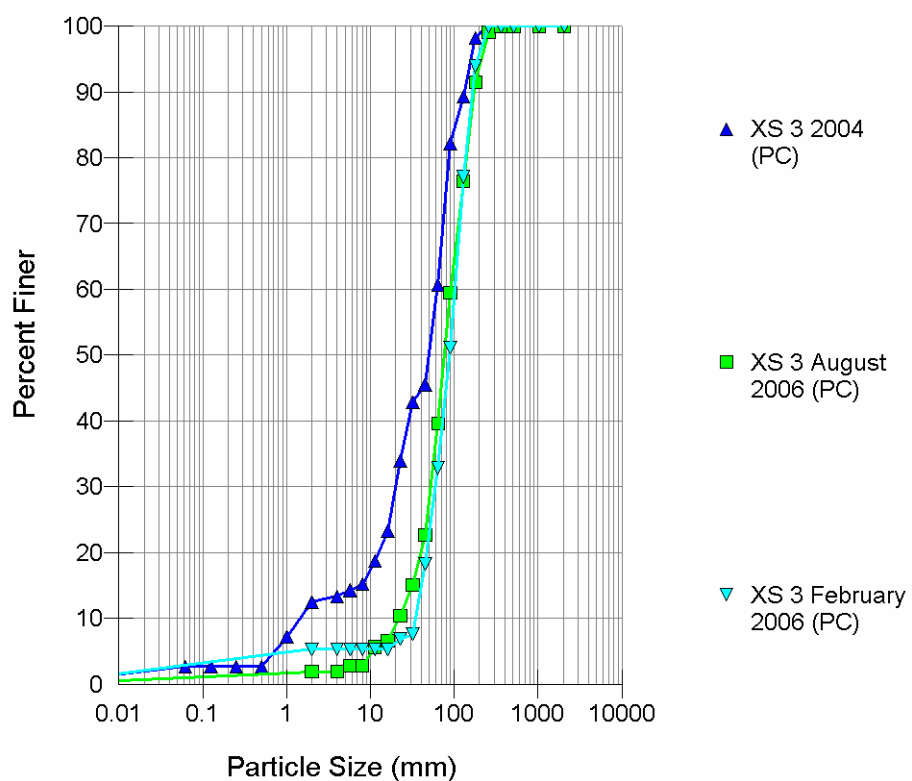
¹ Maximum particle size sampled from downstream one-third of point bar² Geometric mean of the 30 largest sampled particles³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR 3B, Cross-Section 1 (Point Bar/Pool)

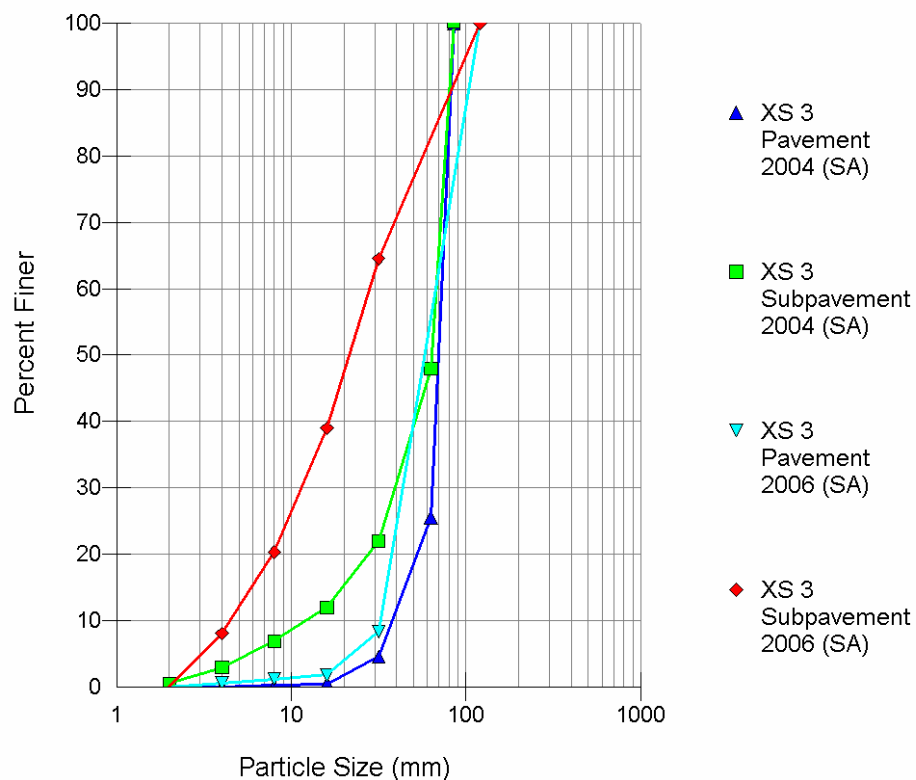
Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	36	14	54	2
D35	50	27	71	20
D50	61	39	81	28
D84	94	82	102	61
D95	105	101	109	94
D100	110	110	112	112

Reach: **CFR 3B**Cross-Section: **3**Channel Unit: **Riffle****Wolman Pebble Count**

Wolman Pebble Count Results (mm)
CFR 3B, Cross-Section 3 (Riffle)

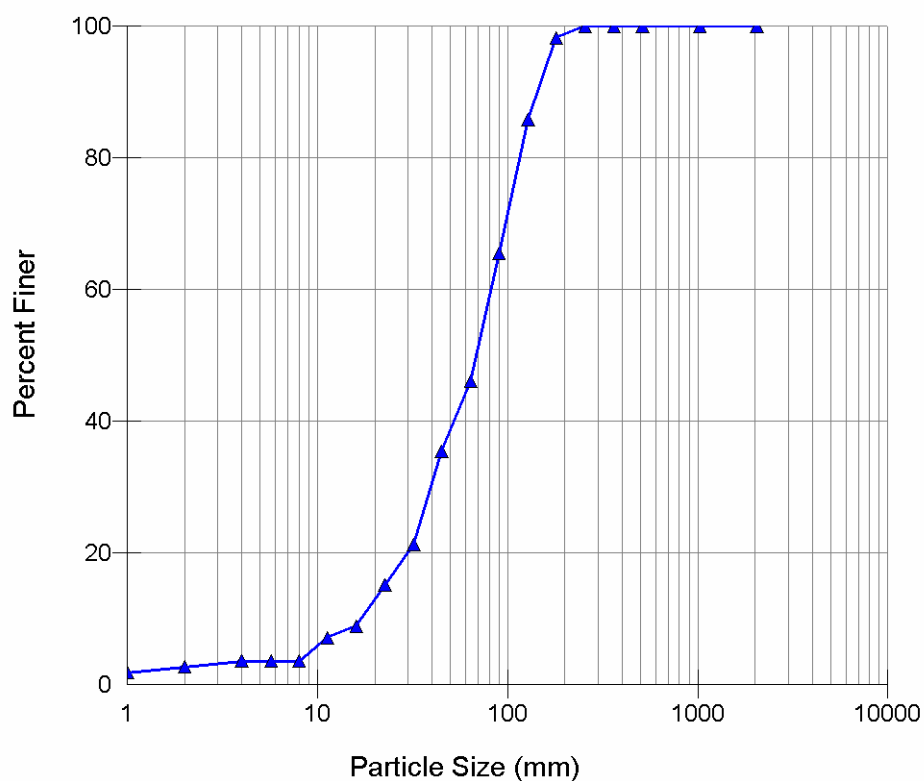
Size Class	2004	Feb 2006	Aug 2006	Mean
D16	9	42	34	28
D35	24	67	59	50
D50	51	88	78	72
D84	100	149	154	134
D95	161	194	215	190
D100	256	256	362	291

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR 3B, Cross-Section 3 (Riffle)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	49	22	47	7
D35	66	47	69	16
D50	70	64	81	26
D84	80	78	107	77
D95	84	83	116	107
D100	85	85	120	120

Reach: **CFR 3B**Cross-Section: **4**Channel Unit: **Riffle****Wolman Pebble Count**

Wolman Pebble Count Results (mm)
CFR 3B, Cross-Section 4 (Riffle)

Size Class	2004	Feb 2006	Aug 2006
D16	n/a	n/a	24
D35	n/a	n/a	45
D50	n/a	n/a	69
D84	n/a	n/a	125
D95	n/a	n/a	166
D100	n/a	n/a	256

Riffle Stability Index (RSI) Results (mm)
CFR 3B, Cross-Section 4 (Riffle)

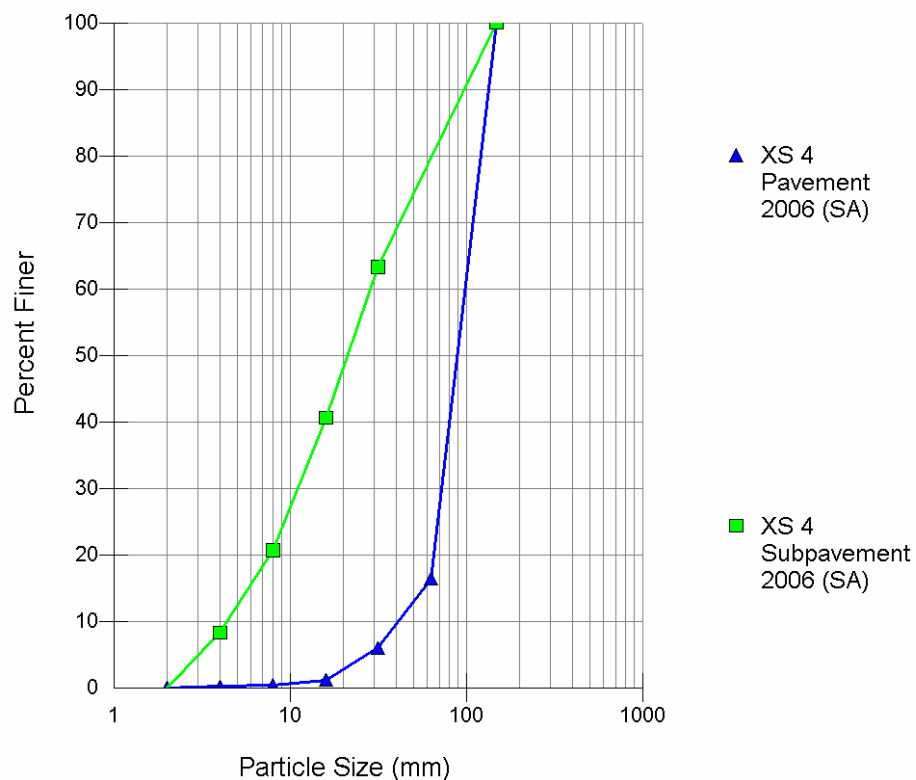
2004			2006		
Max ¹	Mean ²	RSI Score ³	Max	Mean	RSI Score
n/a	n/a	n/a	155	120	D80

¹ Maximum particle size sampled from downstream one-third of point bar

² Geometric mean of the 30 largest sampled particles

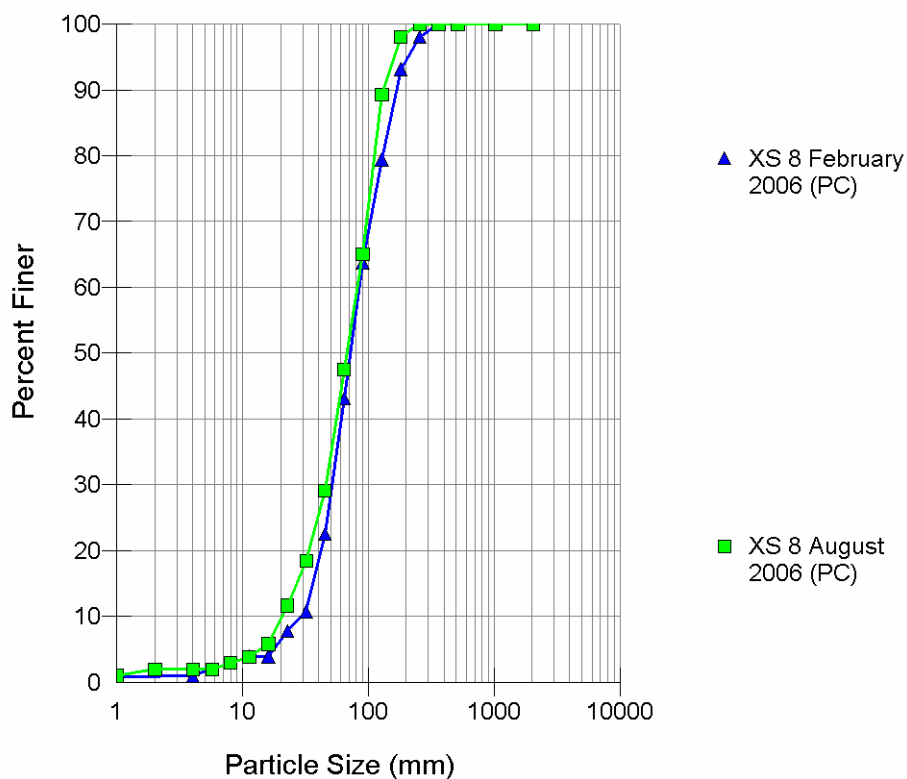
³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR 3B, Cross-Section 4 (Riffle)

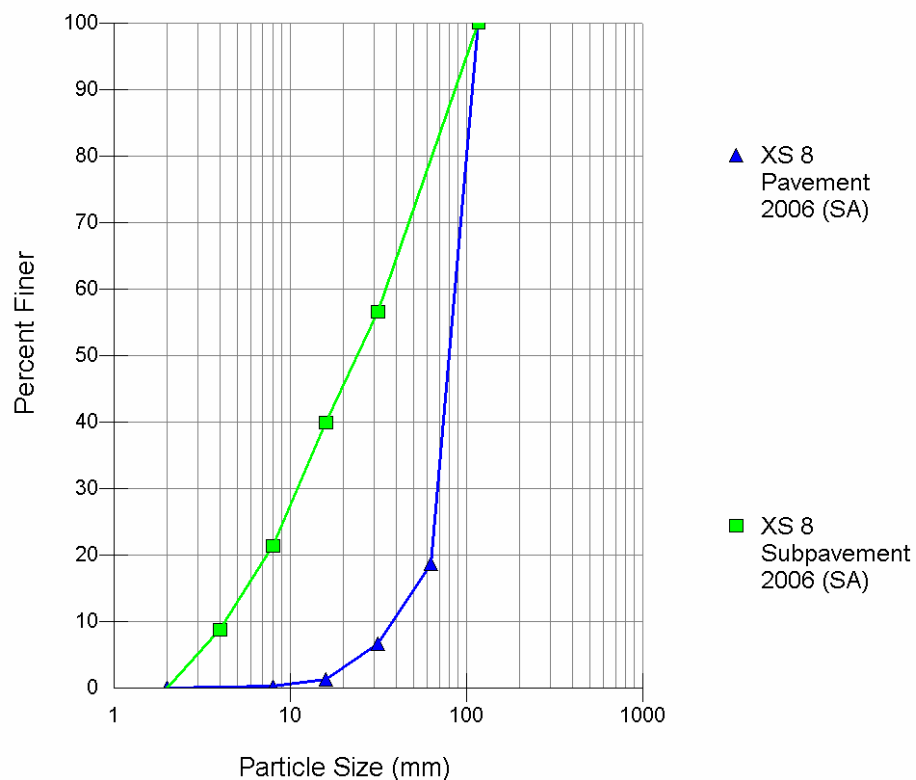
Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	n/a	n/a	62	7
D35	n/a	n/a	82	14
D50	n/a	n/a	97	24
D84	n/a	n/a	132	100
D95	n/a	n/a	143	133
D100	n/a	n/a	148	148

Reach: **CFR 3B**Cross-Section: **8**Channel Unit: **Glide****Wolman Pebble Count**

Wolman Pebble Count Results (mm)
CFR 3B, Cross-Section 8 (Glide)

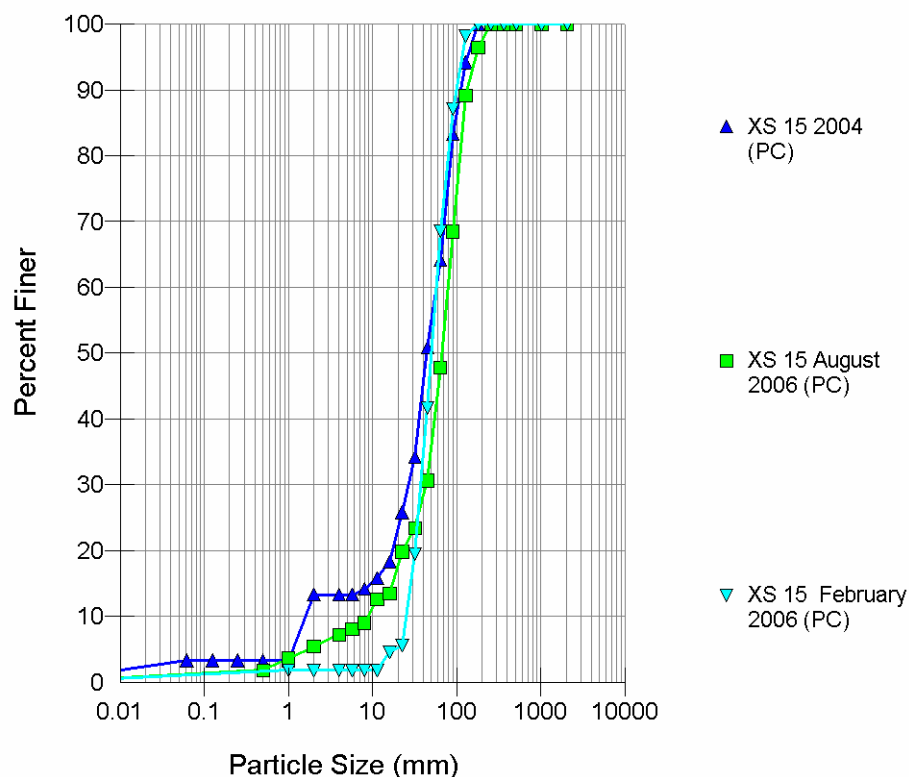
Size Class	2004	Feb 2006	Aug 2006	Mean
D16	n/a	38	29	33
D35	n/a	57	51	54
D50	n/a	73	68	70
D84	n/a	145	120	133
D95	n/a	209	162	186
D100	n/a	362	256	309

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR 3B, Cross-Section 8 (Glide)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	n/a	n/a	56	7
D35	n/a	n/a	74	15
D50	n/a	n/a	84	30
D84	n/a	n/a	106	91
D95	n/a	n/a	114	109
D100	n/a	n/a	117	117

Reach: **CFR 3B**Cross-Section: **15**Channel Unit: **Riffle****Wolman Pebble Count****Wolman Pebble Count Results (mm)**

CFR 3B, Cross-Section 15 (Riffle)

Size Class	2004	Feb 2006	Aug 2006	Mean
D16	12	30	19	20
D35	33	41	50	41
D50	44	51	67	54
D84	92	86	118	99
D95	135	117	170	141
D100	180	180	256	205

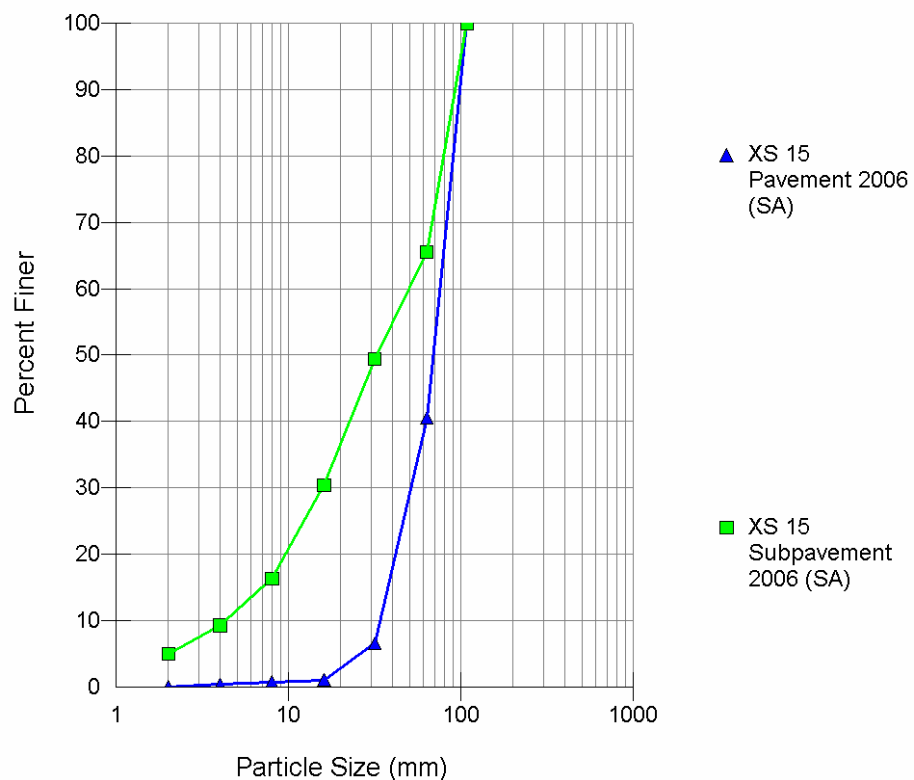
Riffle Stability Index (RSI) Results (mm)

CFR 3B, Cross-Section 15 (Riffle)

2004			2006		
Max ¹	Mean ²	RSI Score ³	Max	Mean	RSI Score
205	131	D92	150	112	D80

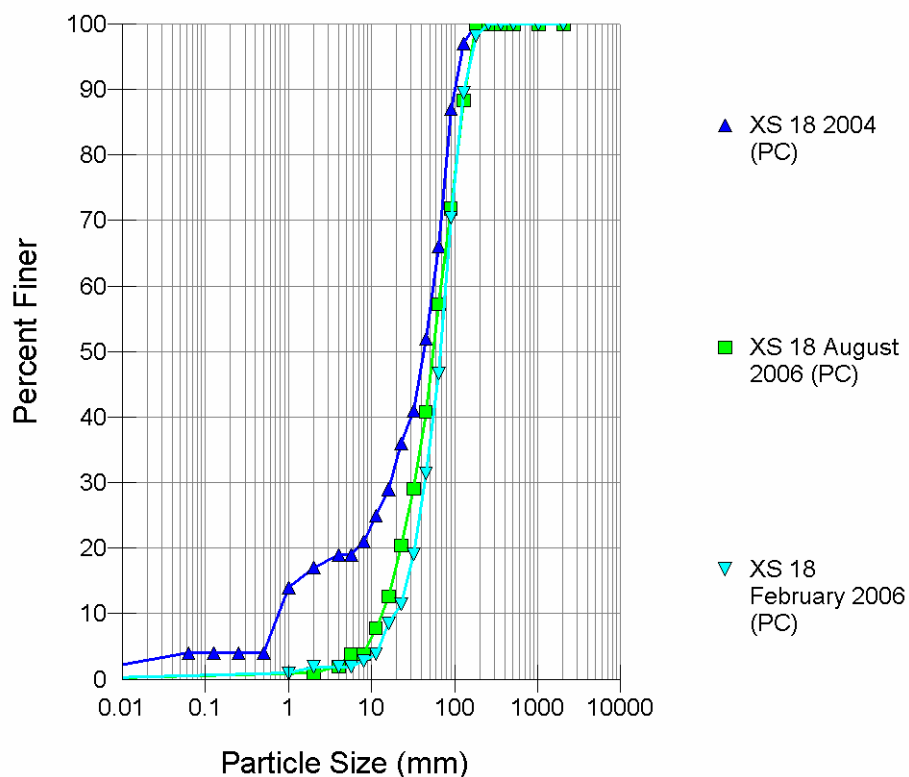
¹ Maximum particle size sampled from downstream one-third of point bar² Geometric mean of the 30 largest sampled particles³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR 3B, Cross-Section 15 (Riffle)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	n/a	n/a	40	8
D35	n/a	n/a	58	20
D50	n/a	n/a	70	33
D84	n/a	n/a	96	87
D95	n/a	n/a	104	101
D100	n/a	n/a	108	108

Reach: **CFR 3B**Cross-Section: **18**Channel Unit: **Riffle****Wolman Pebble Count****Wolman Pebble Count Results (mm)**

CFR 3B, Cross-Section 18 (Riffle)

Size Class	2004	Feb 2006	Aug 2006	Mean
D16	2	28	19	16
D35	22	50	39	37
D50	43	68	56	55
D84	86	117	118	107
D95	120	161	158	146
D100	180	256	180	205

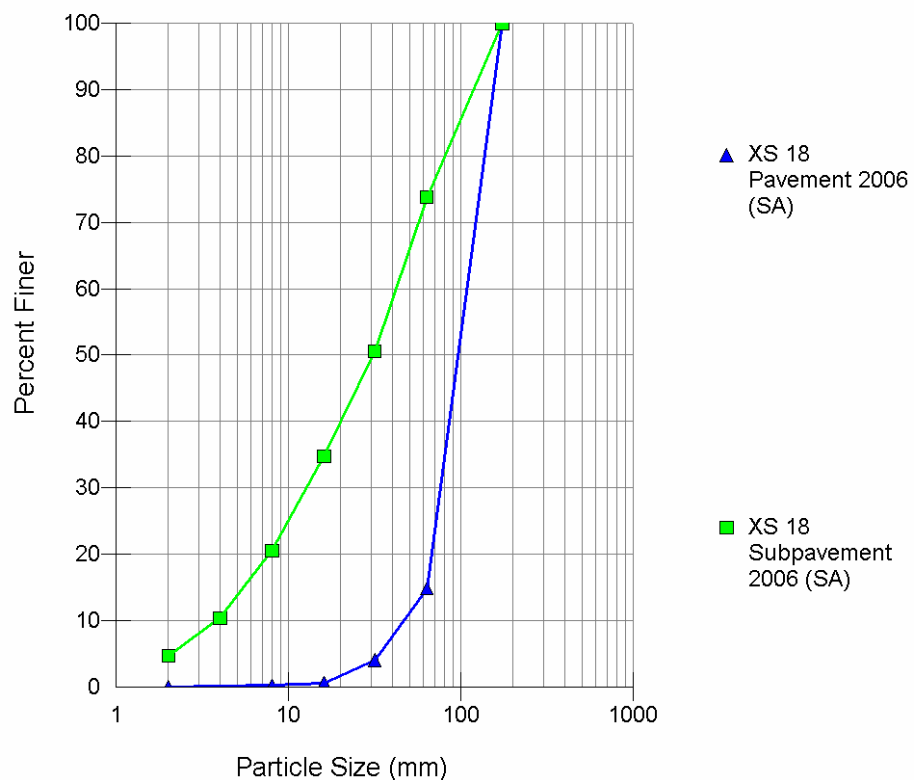
Riffle Stability Index (RSI) Results (mm)

CFR 3B, Cross-Section 18 (Riffle)

2004			2006		
Max ¹	Mean ²	RSI Score ³	Max	Mean	RSI Score
230	159	D98	180	135	D85

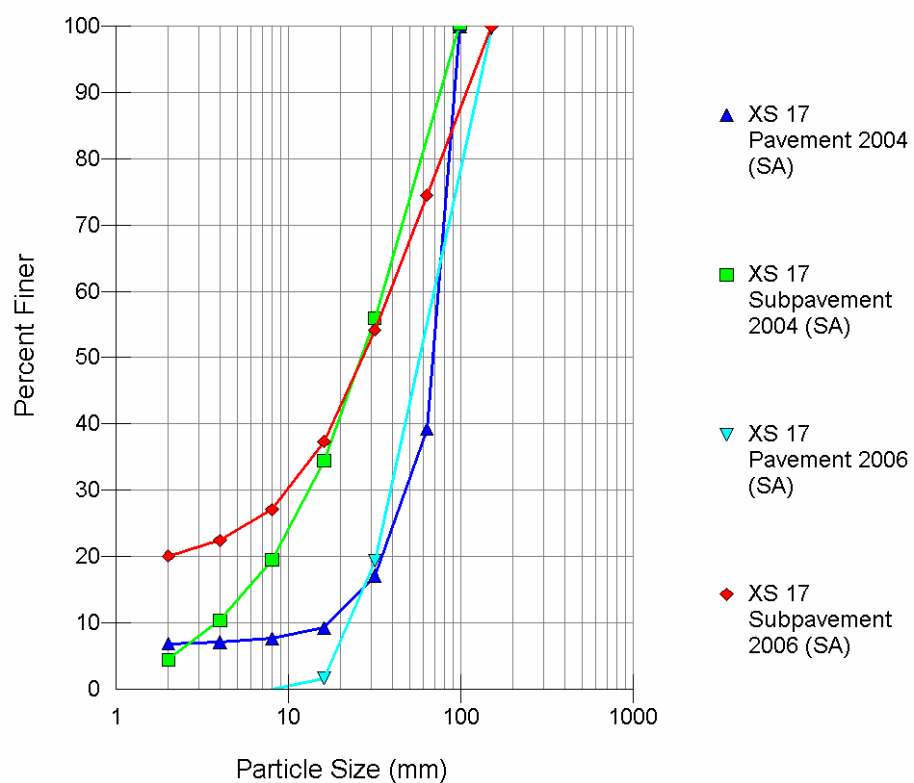
¹ Maximum particle size sampled from downstream one-third of point bar² Geometric mean of the 30 largest sampled particles³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR 3B, Cross-Section 18 (Riffle)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	n/a	n/a	65	6
D35	n/a	n/a	89	16
D50	n/a	n/a	108	31
D84	n/a	n/a	152	106
D95	n/a	n/a	167	152
D100	n/a	n/a	173	173

Reach: **CFR 3B**Cross-Section: **17**Channel Unit: **Glide****Substrate Pavement and Subpavement**

Substrate Pavement and Subpavement (mm)
CFR 3B, Cross-Section 17 (Glide)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	29	7	39	1
D35	57	16	71	14
D50	69	27	89	28
D84	89	74	131	95
D95	95	90	144	133
D100	98	98	150	150

Appendix E

CFR 3C



REACH: CFR 3C**Channel Cross-section Dimensions**

Reach	Cross-section Metric	Riffle						Total Average
		Min	2004 Mean	Max	Min	Aug 2006 Mean	Max	
CFR 3C	Bankfull Area (ft ²)	728	1076	1291	572.0	1002.5	1433.0	1039.3
	Width/Depth Ratio	204	213.3	219	208.0	212.5	217.0	212.9
	Mean Depth (ft)	1.82	2.23	2.44	1.7	2.1	2.6	2.2
	Max Depth (ft)	5.00	6.33	8.61	4.06	4.55	5.04	5.44
	Width (ft)	399.4	475.1	529.3	344.4	450.7	557.0	462.9

Channel Cross-section Dimensionless Ratios

Dimensionless Metric	Min	Mean	Max
Wfpa / Wbkf	4.34	7.65	9.80
Abkf	391.16	484.40	600.19
Dmbkf	5.00	6.33	8.61
Dbkf	3.13	3.67	4.35
Wbkf	125.16	131.39	137.98

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00338	0.00734	0.00989
S pool (ft/ft)	0.00000	0.00000	0.00000
S run (ft/ft)	0.00048	0.00209	0.00743
S glide (ft/ft)	0.00049	0.00121	0.00165
P - P (ft)	0.00	0.00	0.00
P length (ft)	0.00	0.00	0.00
Dmax riffle (ft)	1.60	2.94	3.79
Dmax pool (ft)	0.00	0.00	0.00
Dmax run (ft)	3.60	5.70	10.54
Dmax glide (ft)	2.14	3.31	4.95
Low Bank Ht (ft)	1.69	1.69	1.69
Bankfull Slope (ft/ft)		0.00264	

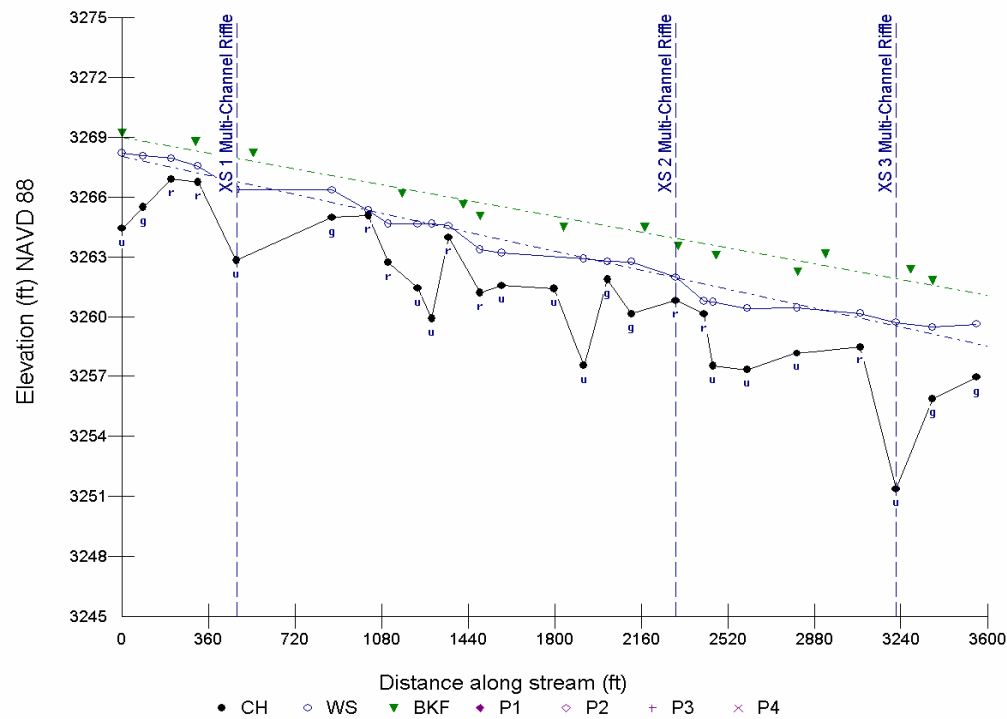
Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.28	2.78	3.75
S pool / S bkf (ft/ft)	0.00	0.00	0.00
S run / S bkf (ft/ft)	0.18	0.79	2.81
S glide / S bkf (ft/ft)	0.19	0.46	0.63
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	0.00	0.00	0.00
Dmax riffle / D bkf (ft)	0.44	0.80	1.03
Dmax pool / D bkf (ft)	0.00	0.00	0.00
Dmax run / D bkf (ft)	0.98	1.55	2.87
Dmax glide / D bkf (ft)	0.58	0.90	1.35
Low Bank Ht / Dmax riff (ft)	0.57	0.57	0.57
Bankfull Slope (ft/ft)		0.00264	

Channel Planform Dimensions and Dimensionless Ratios

Year	Sinuosity (ft/ft)	Meander Belt Width (ft)	Meander Belt Width (ft) / Wbkf
1937	1.30	1775	3.94
1956	1.30	1579	3.50
1966	1.35	1521	3.37
2000	1.18	892	1.98
2005	1.20	829	1.84

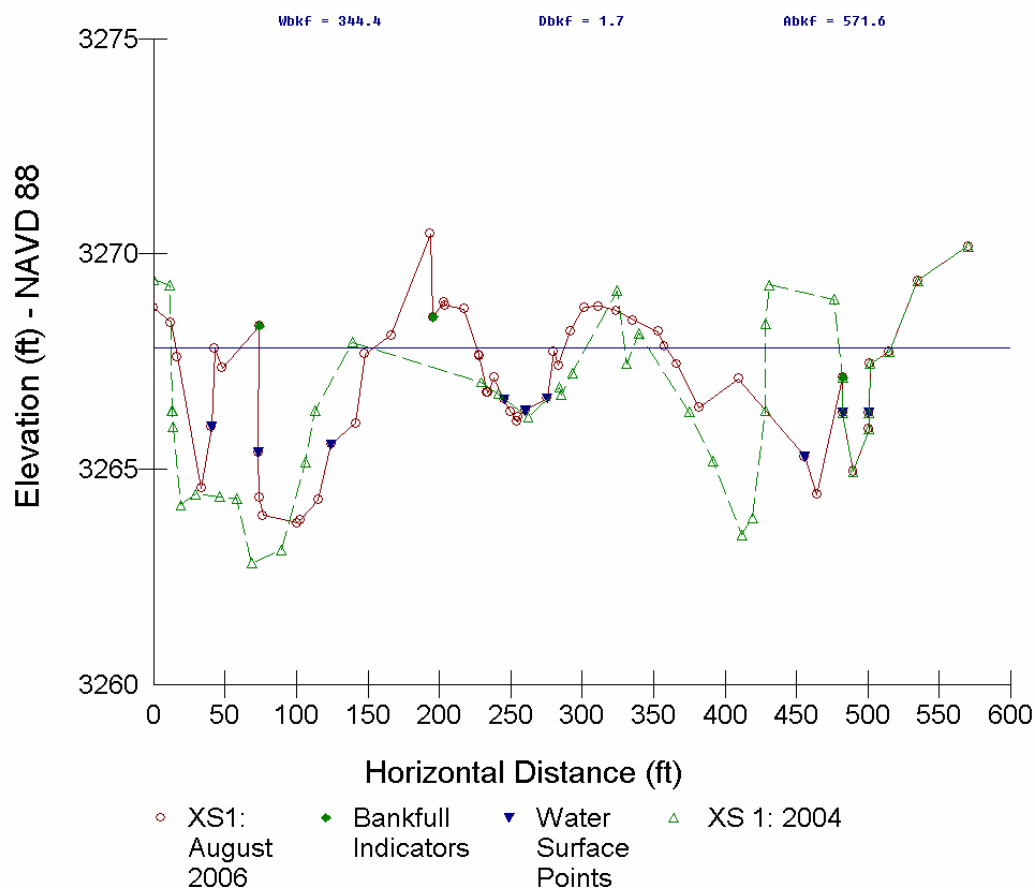
^: An average riffle width of 450.7 ft measured in the August 2004 survey was used to develop the dimensionless ratios.

CFR 3C 2004



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00338	0.00734	0.00989
S pool (ft/ft)	0.00000	0.00000	0.00000
S run (ft/ft)	0.00048	0.00209	0.00743
S glide (ft/ft)	0.00049	0.00121	0.00165
P - P (ft)	0.00	0.00	0.00
P length (ft)	0.00	0.00	0.00
Dmax riffle (ft)	1.60	2.94	3.79
Dmax pool (ft)	0.00	0.00	0.00
Dmax run (ft)	3.60	5.70	10.54
Dmax glide (ft)	2.14	3.31	4.95
Low Bank Ht (ft)	1.69	1.69	1.69
Bankfull Slope (ft/ft)		0.00264	

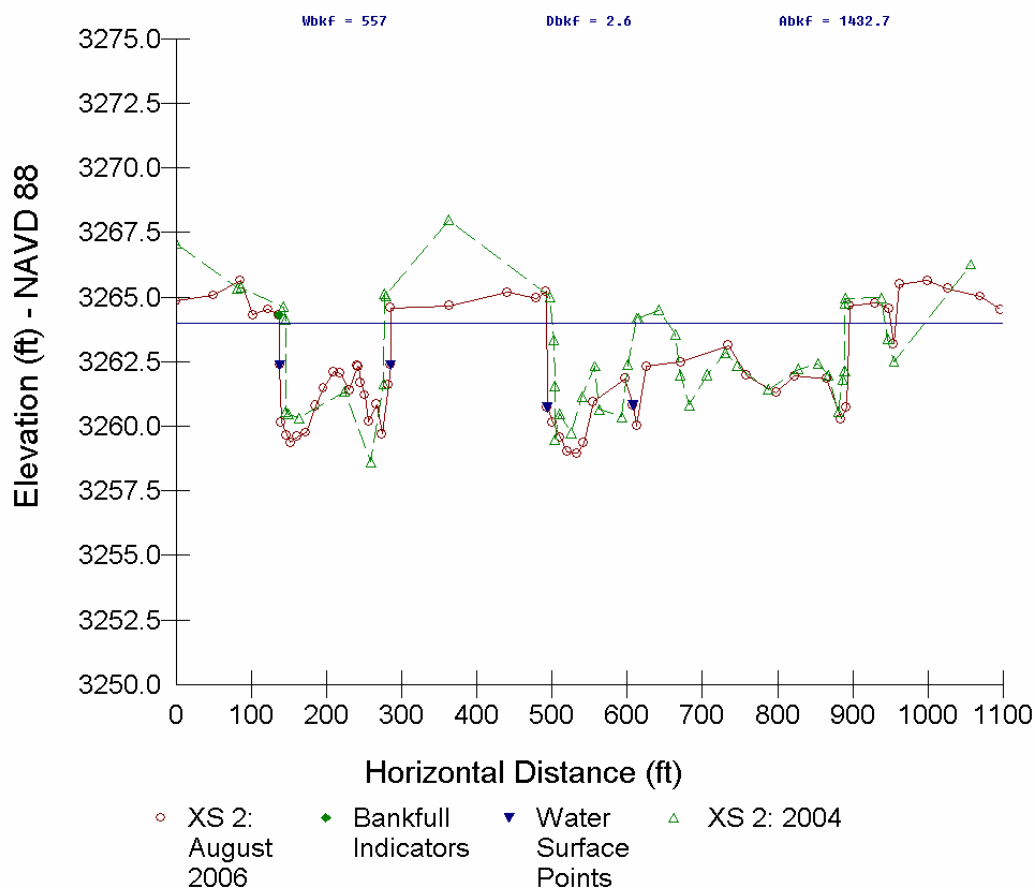
Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.28	2.78	3.75
S pool / S bkf (ft/ft)	0.00	0.00	0.00
S run / S bkf (ft/ft)	0.18	0.79	2.81
S glide / S bkf (ft/ft)	0.19	0.46	0.63
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	0.00	0.00	0.00
Dmax riffle / D bkf (ft)	0.44	0.80	1.03
Dmax pool / D bkf (ft)	0.00	0.00	0.00
Dmax run / D bkf (ft)	0.98	1.55	2.87
Dmax glide / D bkf (ft)	0.58	0.90	1.35
Low Bank Ht / Dmax riff (ft)	0.57	0.57	0.57
Bankfull Slope (ft/ft)		0.00264	

Reach: **CFR 3C**Cross-Section: **1**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3C, Cross-Section 1 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	728	572	650	-21.4
Width/Depth Ratio	219	208	214	-5.0
Bankfull Width (ft)	399	344	372	-13.8
Mean Depth (ft)	1.8	1.67	1.7	-8.8

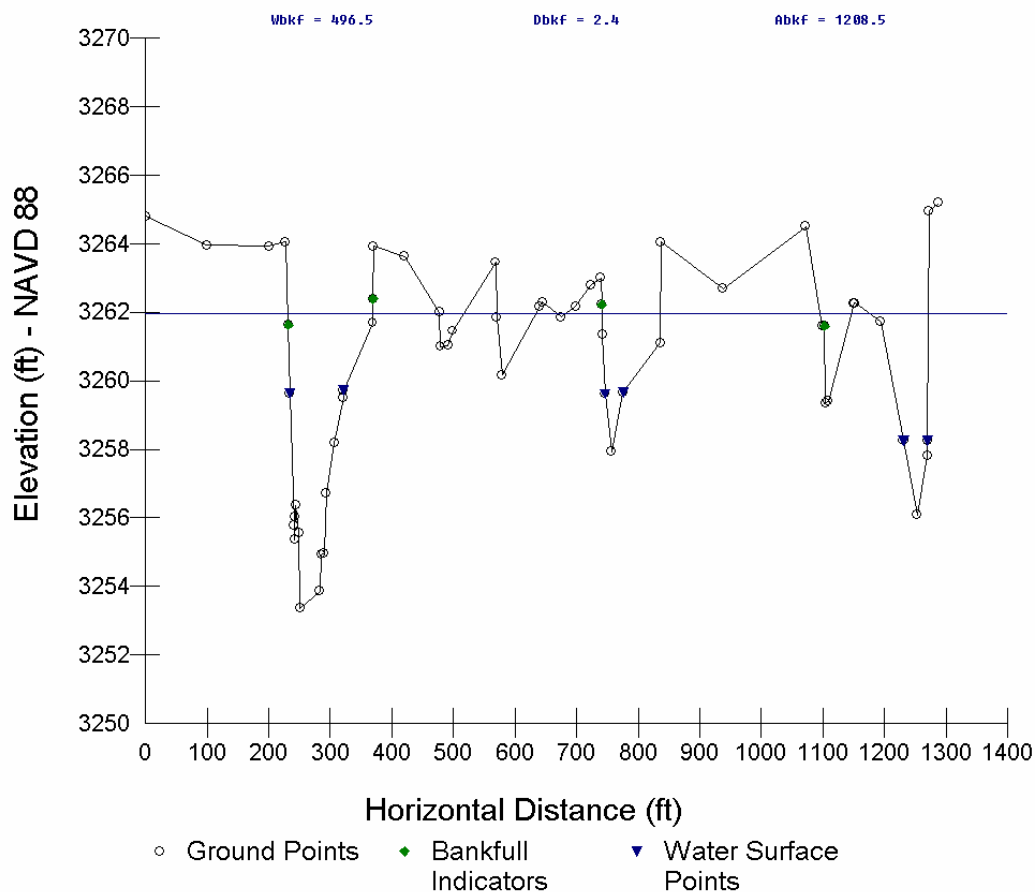
¹ Change from 2004 to 2006

Reach: **CFR 3C**Cross-Section: **2**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3C, Cross-Section 2 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1291	1433	1362	+11.0
Width/Depth Ratio	217	217	217	0.0
Bankfull Width (ft)	529	557	543	+5.2
Mean Depth (ft)	2.4	2.6	2.5	+5.3

¹ Change from 2004 to 2006

Reach: **CFR 3C**Cross-Section: **3**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR 3C, Cross-Section 3 (Riffle)

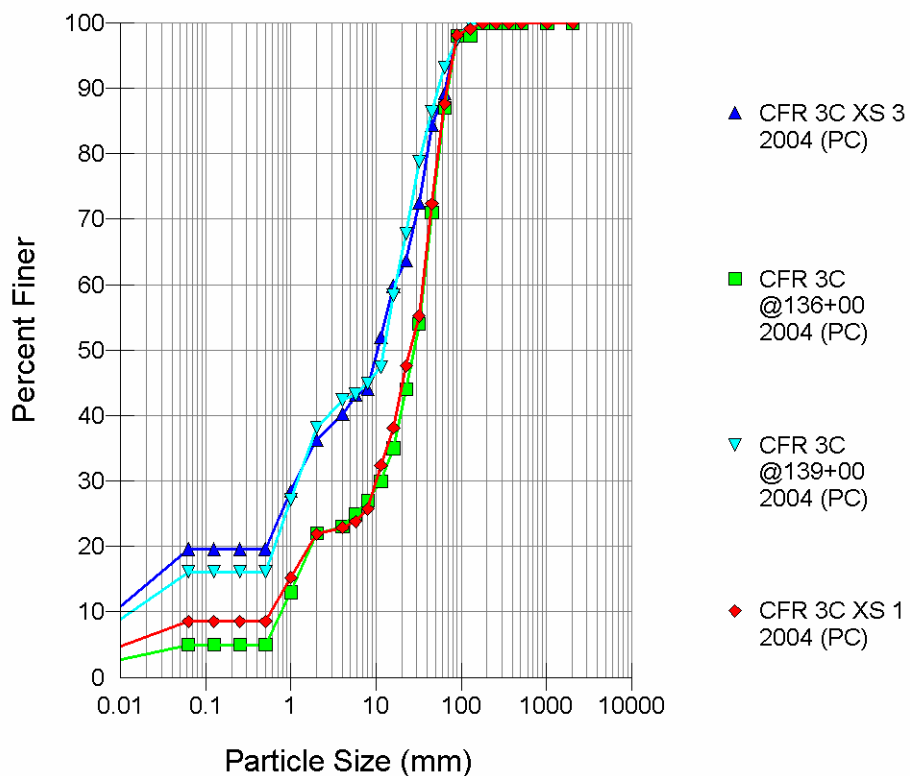
	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1209	n/a	1209	n/a
Width/Depth Ratio	204	n/a	204	n/a
Bankfull Width (ft)	497	n/a	497	n/a
Mean Depth (ft)	2.4	n/a	2.4	n/a

¹ Change from 2004 to 2006

Reach CFR 3C

Cross-Section: 1, 3
Sta. 136+00 & Sta. 139+00

Channel Unit: Riffles

Wolman Pebble Count

Wolman Pebble Count Results (mm) (2004)
 CFR 3C (Riffles)

Size Class	XS 1	139+00	136+00	XS 3	Mean
D16	1	<1	1	<1	<1
D35	13	2	16	2	8
D50	26	12	28	11	19
D84	60	41	60	45	51
D95	82	75	83	81	80
D100	180	128	180	180	167

Riffle Stability Index (RSI) Results (mm) (2004)
 CFR 3C (Riffles)

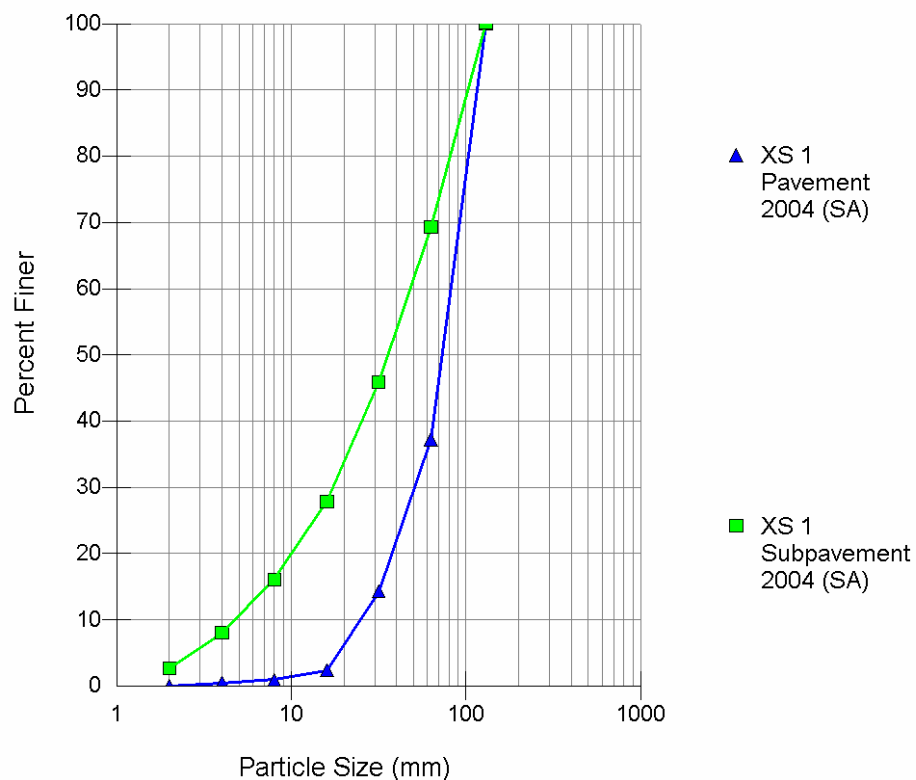
Bar Count		RSI Score ³ by Site			
Max ¹	Mean ²	XS 1	139+00	136+00	XS 3
140	102	D98	D98	D99	D98

¹ Maximum particle size sampled from downstream one-third of point bar

² Geometric mean of the 30 largest sampled particles

³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm) (2004)
CFR 3C, Cross-Section 1 (Riffle)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	34	8	n/a	n/a
D35	60	22	n/a	n/a
D50	77	37	n/a	n/a
D84	113	95	n/a	n/a
D95	125	119	n/a	n/a
D100	130	130	n/a	n/a

Appendix F

CFR Bandmann



REACH: CFR BANDMANN FLATS**Channel Cross-section Dimensions**

Reach	Cross-section Metric	Riffle			Run		
		Min	2004 Mean	Max	Min	2004 Mean	Max
CFR Bandmann	Bankfull Area (ft ²)	1013.6	1200.7	1376.0	1296.3	1300.2	1304.0
	Width/Depth Ratio	45.3	55.2	50.1	36.4	37.4	37.3
	Mean Depth (ft)	4.5	4.7	4.9	5.8	5.9	6.0
	Max Depth (ft)	5.7	6.7	7.6	8.3	8.7	9.1
	Width (ft)	223.3	257.7	298.3	217.3	220.8	224.3

Reach	Cross-section Metric	Pool			Glide		
		Min	2004 Mean	Max	Min	2004 Mean	Max
CFR Bandmann	Bankfull Area (ft ²)	1836.0	2216.0	2596.0	1389.3	1557.9	1848.8
	Width/Depth Ratio	16.1	18.4	20.7	31.6	46.5	50.4
	Mean Depth (ft)	10.7	11.0	11.2	4.8	5.8	7.7
	Max Depth (ft)	23.0	23.3	23.5	6.8	8.6	12.0
	Width (ft)	172.0	2015	231.0	241.7	271.5	289.5

Channel Cross-section Dimensionless Ratios

Dimensionless Metric	Mean
Wfpa / Wbkf	1.08
Abkf	1376.04
Dmbkf	6.13
Dbkf	4.61
Wbkf	298.30

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

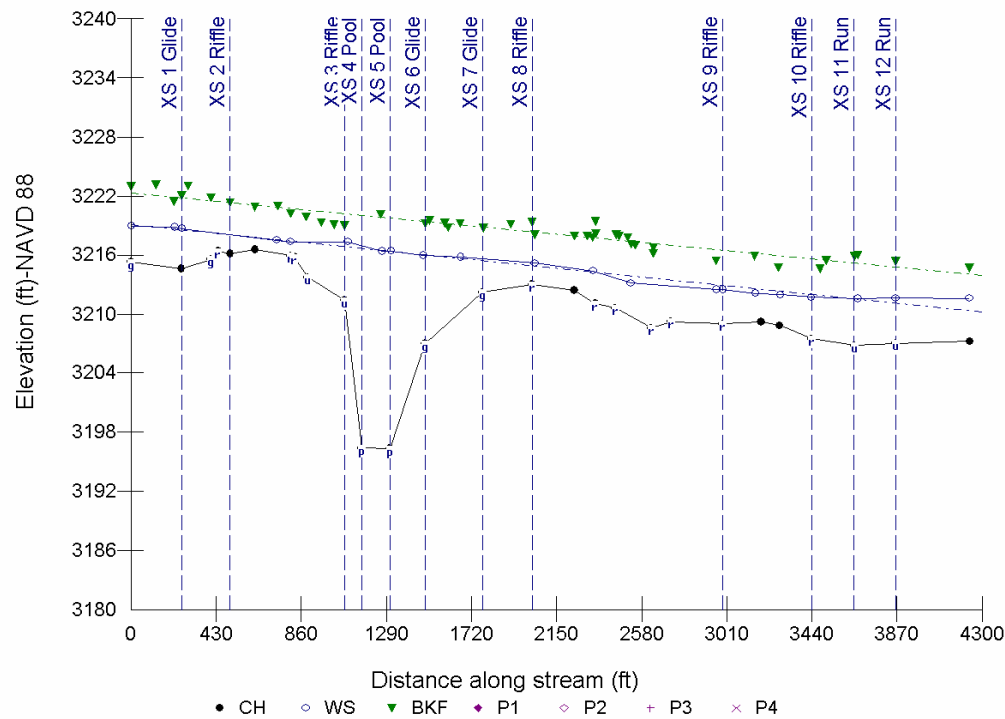
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00158	0.00306	0.00563
S pool (ft/ft)	0.00244	0.00244	0.00244
S run (ft/ft)	0.00564	0.00564	0.00564
S glide (ft/ft)	0.00086	0.00165	0.00243
P - P (ft)	0.00	0.00	0.00
P length (ft)	395.06	395.06	395.06
Dmax riffle (ft)	4.87	5.98	7.08
Dmax pool (ft)	23.67	23.67	23.67
Dmax run (ft)	7.69	7.69	7.69
Dmax glide (ft)	6.24	7.95	9.66
Low Bank Ht (ft)	4.79	4.83	4.87
Bankfull Slope (ft/ft)		0.00191	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.83	1.60	2.95
S pool / S bkf (ft/ft)	1.28	1.28	1.28
S run / S bkf (ft/ft)	2.95	2.95	2.95
S glide / S bkf (ft/ft)	0.45	0.86	1.27
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	1.32	1.32	1.32
Dmax riffle / D bkf (ft)	1.06	1.30	1.54
Dmax pool / D bkf (ft)	5.13	5.13	5.13
Dmax run / D bkf (ft)	1.67	1.67	1.67
Dmax glide / D bkf (ft)	1.35	1.72	2.10
Low Bank Ht / Dmax riff (ft)	0.80	0.81	0.81
Bankfull Slope (ft/ft)		0.00191	

Channel Planform Dimensions and Dimensionless Ratios

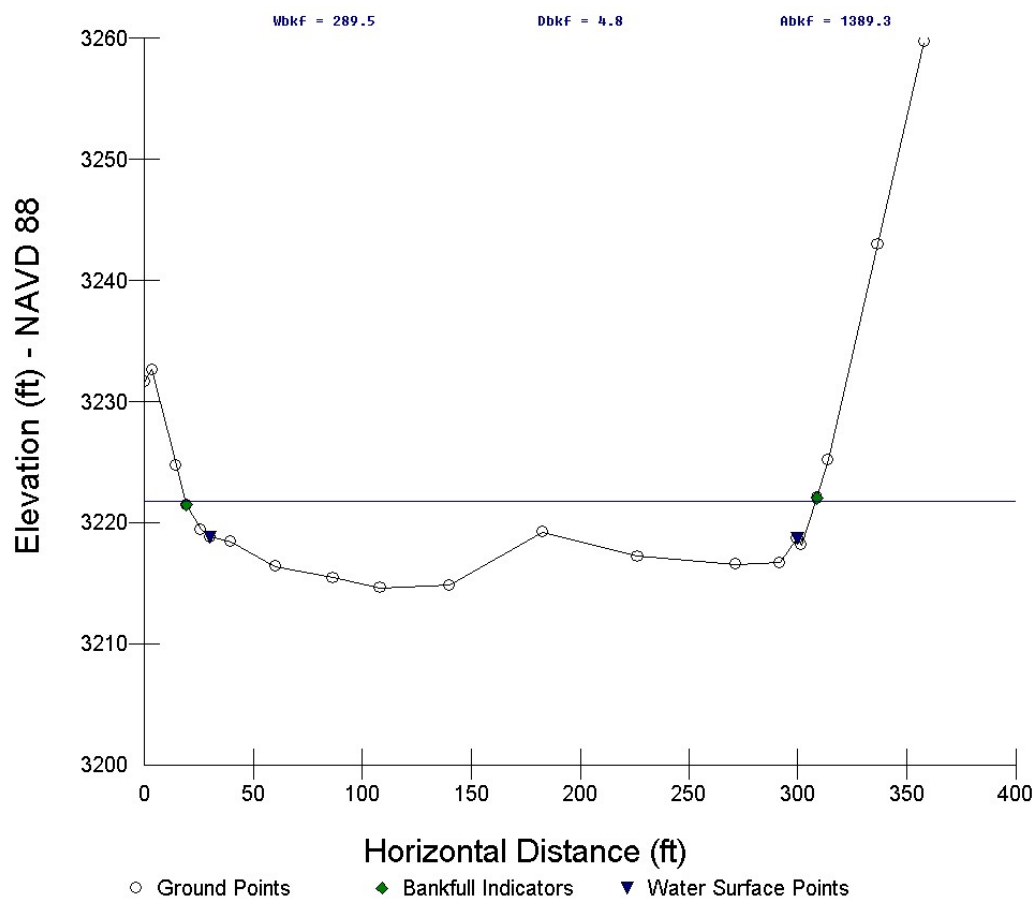
No Data

CFR Bandmann 2004



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00158	0.00306	0.00563
S pool (ft/ft)	0.00244	0.00244	0.00244
S run (ft/ft)	0.00620	0.00620	0.00620
S glide (ft/ft)	0.00086	0.00165	0.00243
P - P (ft)	0.00	0.00	0.00
P length (ft)	395.06	395.06	395.06
Dmax riffle (ft)	4.87	5.98	7.08
Dmax pool (ft)	23.67	23.67	23.67
Dmax run (ft)	7.69	7.69	7.69
Dmax glide (ft)	6.24	7.95	9.66
Low Bank Ht (ft)	4.79	4.83	4.87
Bankfull Slope (ft/ft)		0.00191	

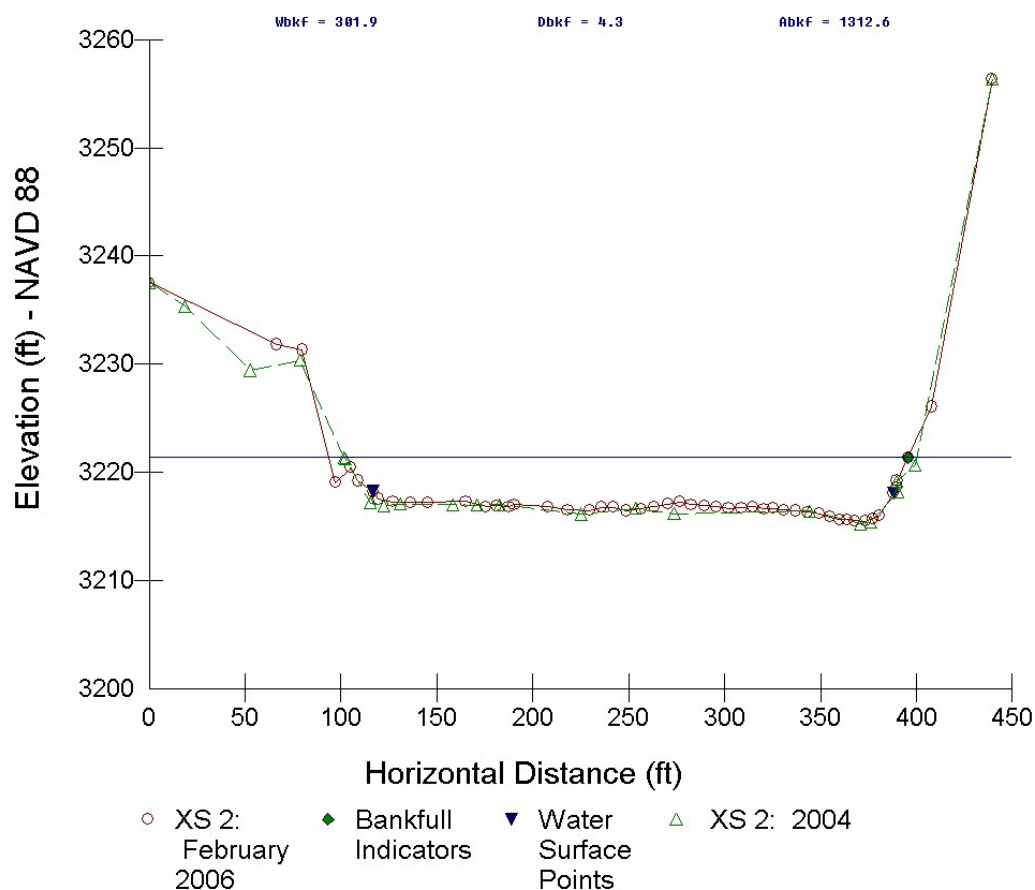
Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.83	1.60	2.95
S pool / S bkf (ft/ft)	1.28	1.28	1.28
S run / S bkf (ft/ft)	3.25	3.25	3.25
S glide / S bkf (ft/ft)	0.45	0.86	1.27
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	1.32	1.32	1.32
Dmax riffle / D bkf (ft)	1.06	1.30	1.54
Dmax pool / D bkf (ft)	5.13	5.13	5.13
Dmax run / D bkf (ft)	1.67	1.67	1.67
Dmax glide / D bkf (ft)	1.35	1.72	2.10
Low Bank Ht / Dmax riff (ft)	0.80	0.81	0.81
Bankfull Slope (ft/ft)		0.00191	

Reach: **CFR Bandmann**Cross-Section: **1**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR Bandmann, Cross-Section 1 (Glide)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1390	n/a	1390	n/a
Width/Depth Ratio	60.3	n/a	60.3	n/a
Bankfull Width (ft)	289	n/a	289	n/a
Mean Depth (ft)	4.8	n/a	4.8	n/a

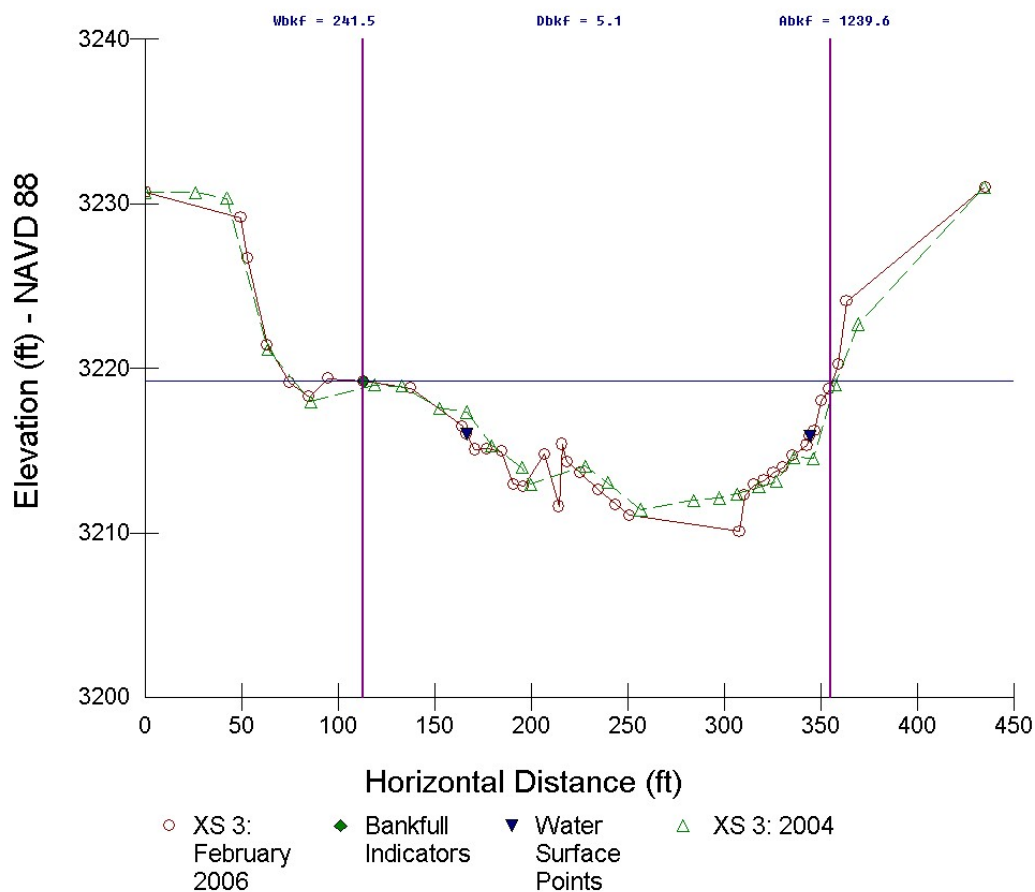
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **2**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR Bandmann, Cross-Section 2 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1376	1313	1345	-4.6
Width/Depth Ratio	64.7	69.4	67.1	+7.3
Bankfull Width (ft)	298	302	300	+1.3
Mean Depth (ft)	4.6	4.4	4.5	-4.3

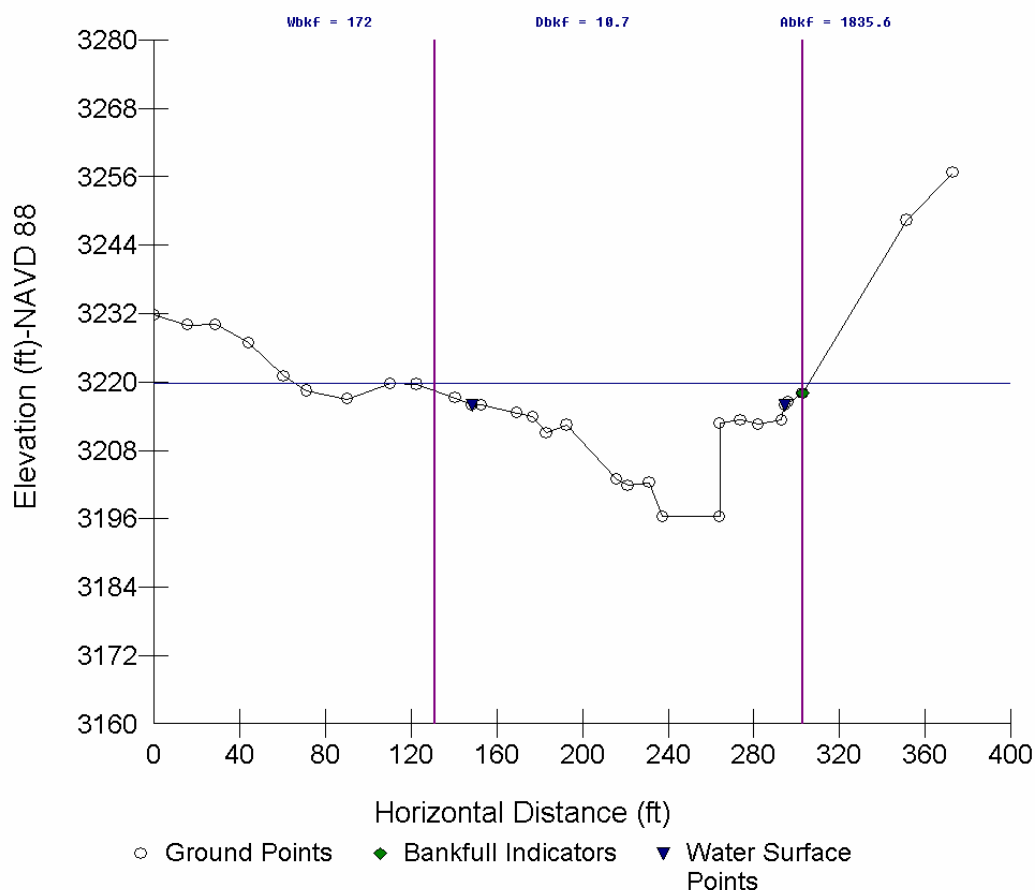
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **3**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR Bandmann, Cross-Section 3 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1101	1240	1171	+12.6
Width/Depth Ratio	45.3	47.1	46.2	+4.0
Bankfull Width (ft)	223	241	232	+8.1
Mean Depth (ft)	4.9	5.1	5.0	+4.1

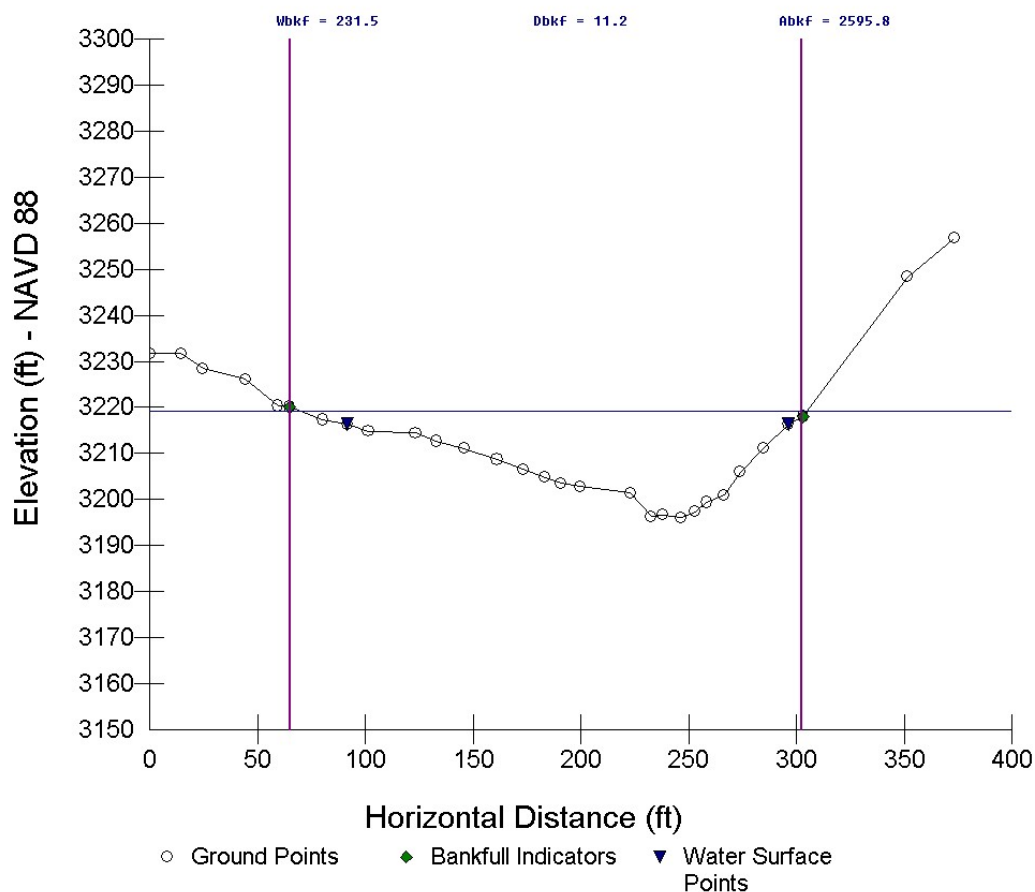
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **4**Channel Unit: **Pool**

Channel Cross-Section Summary Data
CFR Bandmann, Cross-Section 4 (Pool)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1836	n/a	1836	n/a
Width/Depth Ratio	16.1	n/a	16.1	n/a
Bankfull Width (ft)	172	n/a	172	n/a
Mean Depth (ft)	10.7	n/a	10.7	n/a

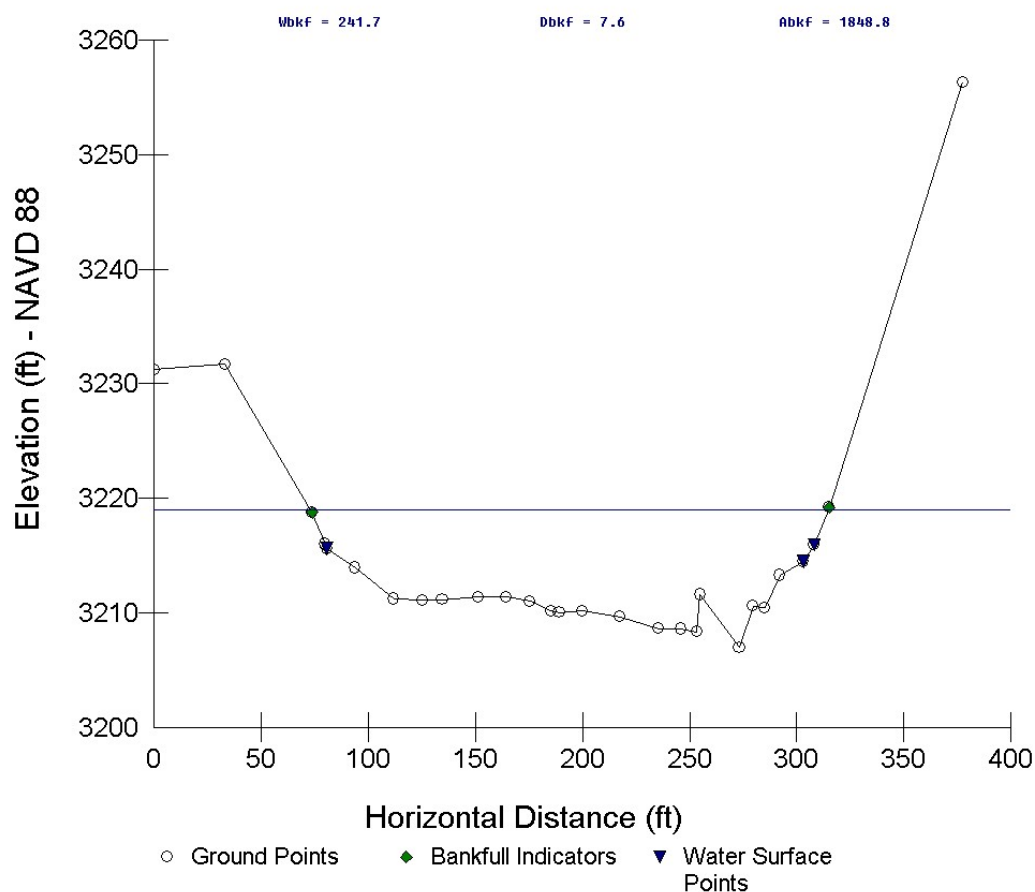
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **5**Channel Unit: **Pool**

Channel Cross-Section Summary Data
CFR Bandmann, Cross-Section 5 (Pool)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	2596	n/a	2596	n/a
Width/Depth Ratio	20.7	n/a	20.7	n/a
Bankfull Width (ft)	231	n/a	231	n/a
Mean Depth (ft)	11.2	n/a	11.2	n/a

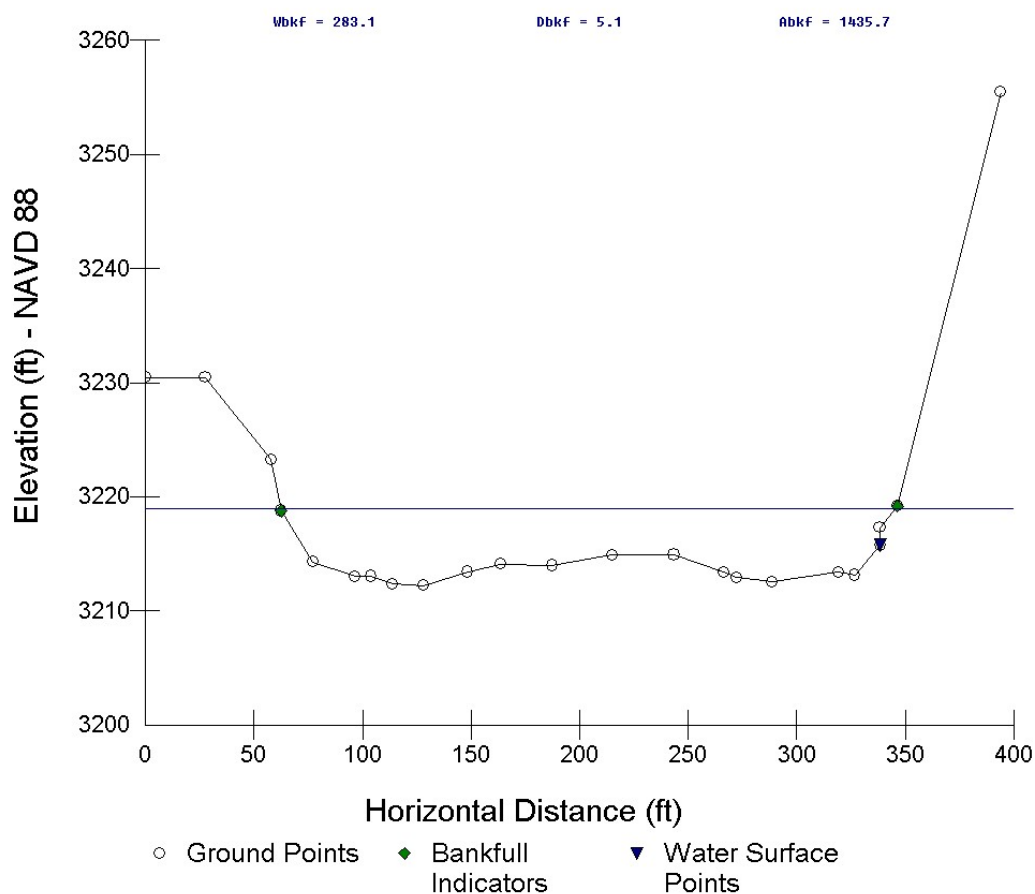
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **6**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR Bandmann, Cross-Section 6 (Glide)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1849	n/a	1849	n/a
Width/Depth Ratio	31.6	n/a	31.6	n/a
Bankfull Width (ft)	242	n/a	242	n/a
Mean Depth (ft)	7.7	n/a	7.7	n/a

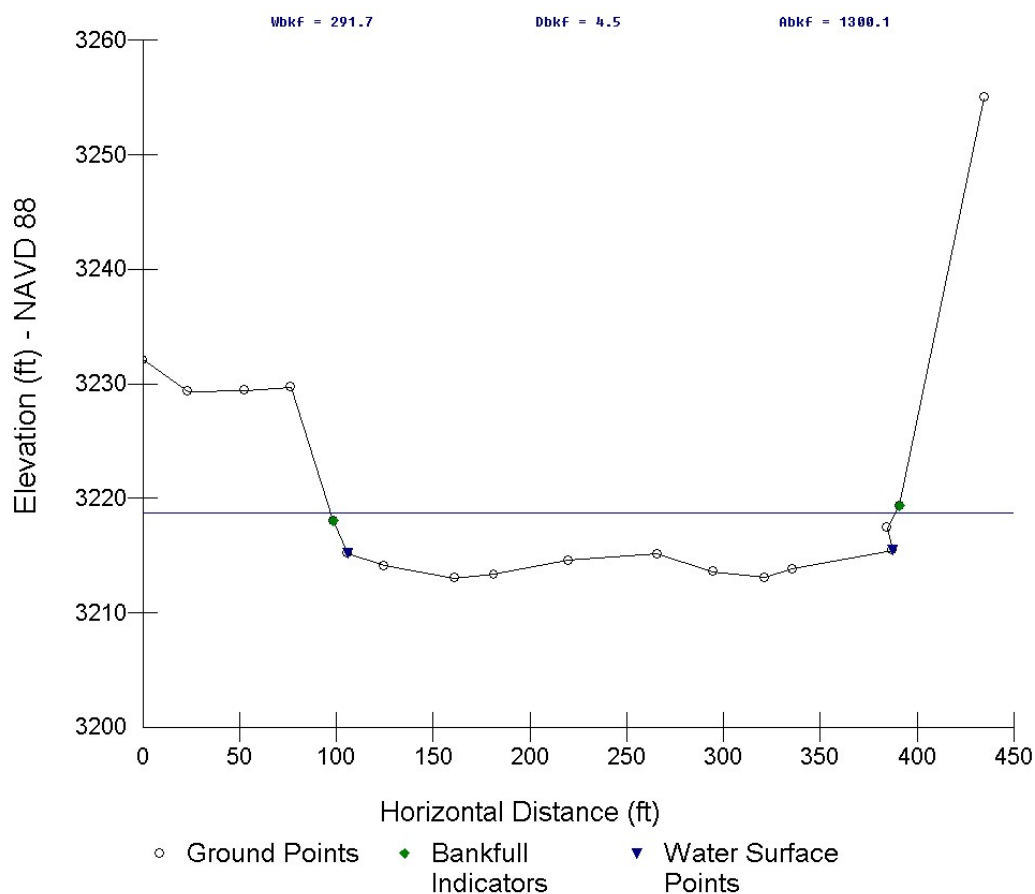
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **7**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR Bandmann, Cross-Section 7 (Glide)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1436	n/a	1436	n/a
Width/Depth Ratio	55.8	n/a	55.8	n/a
Bankfull Width (ft)	283	n/a	283	n/a
Mean Depth (ft)	5.1	n/a	5.1	n/a

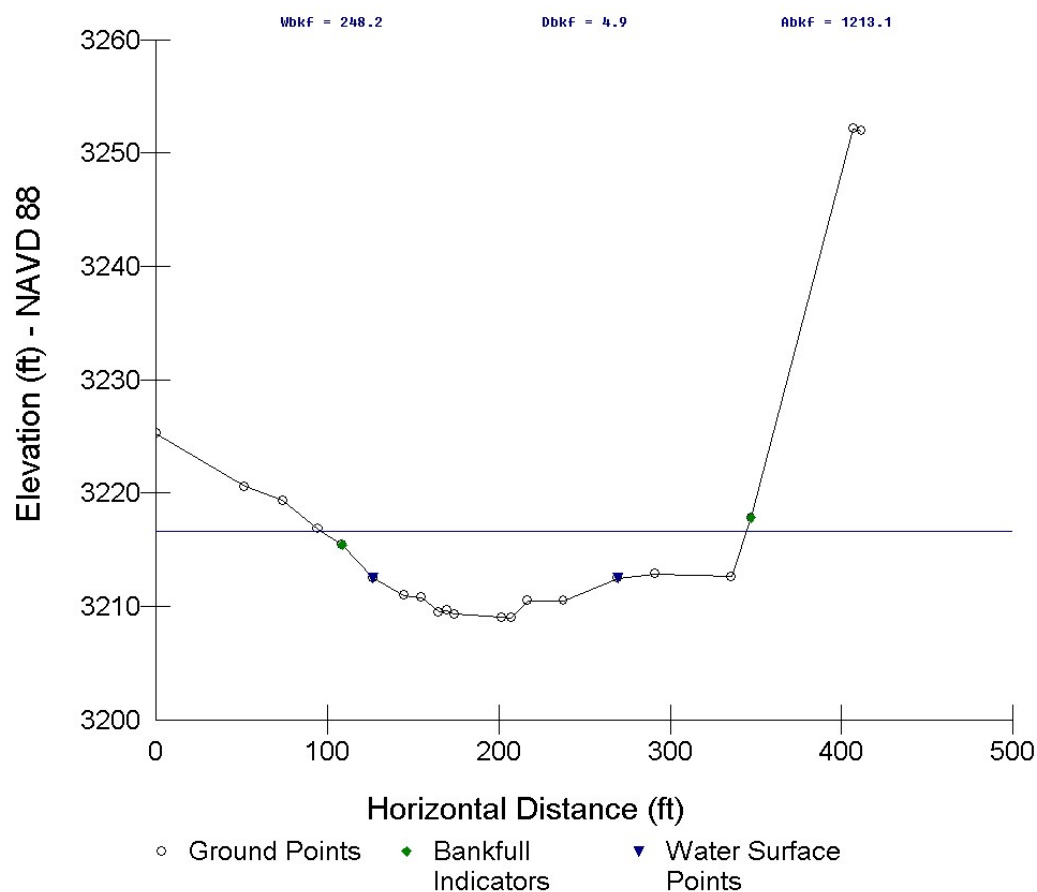
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **8**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR Bandmann, Cross-Section 8 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1300	n/a	1300	n/a
Width/Depth Ratio	65.4	n/a	65.4	n/a
Bankfull Width (ft)	292	n/a	292	n/a
Mean Depth (ft)	4.5	n/a	4.5	n/a

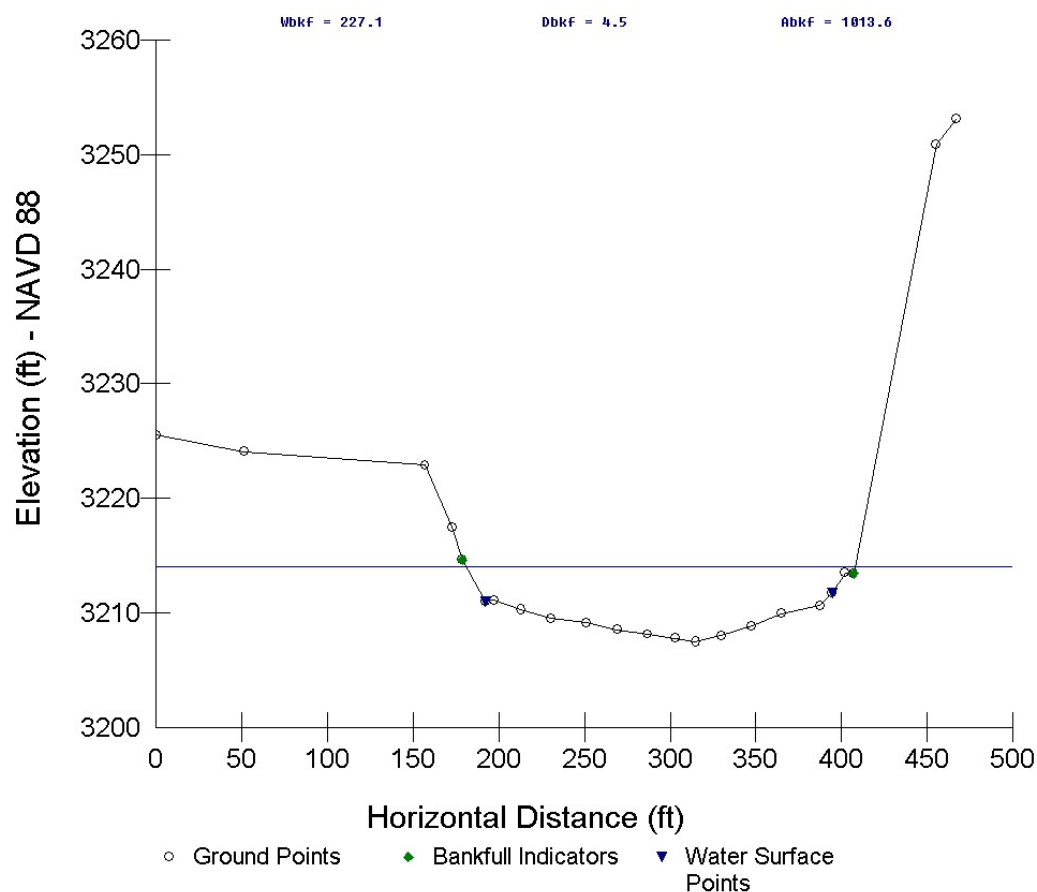
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **9**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
 CFR Bandmann, Cross-Section 9 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1213	n/a	1213	n/a
Width/Depth Ratio	50.8	n/a	50.8	n/a
Bankfull Width (ft)	248	n/a	248	n/a
Mean Depth (ft)	4.9	n/a	4.9	n/a

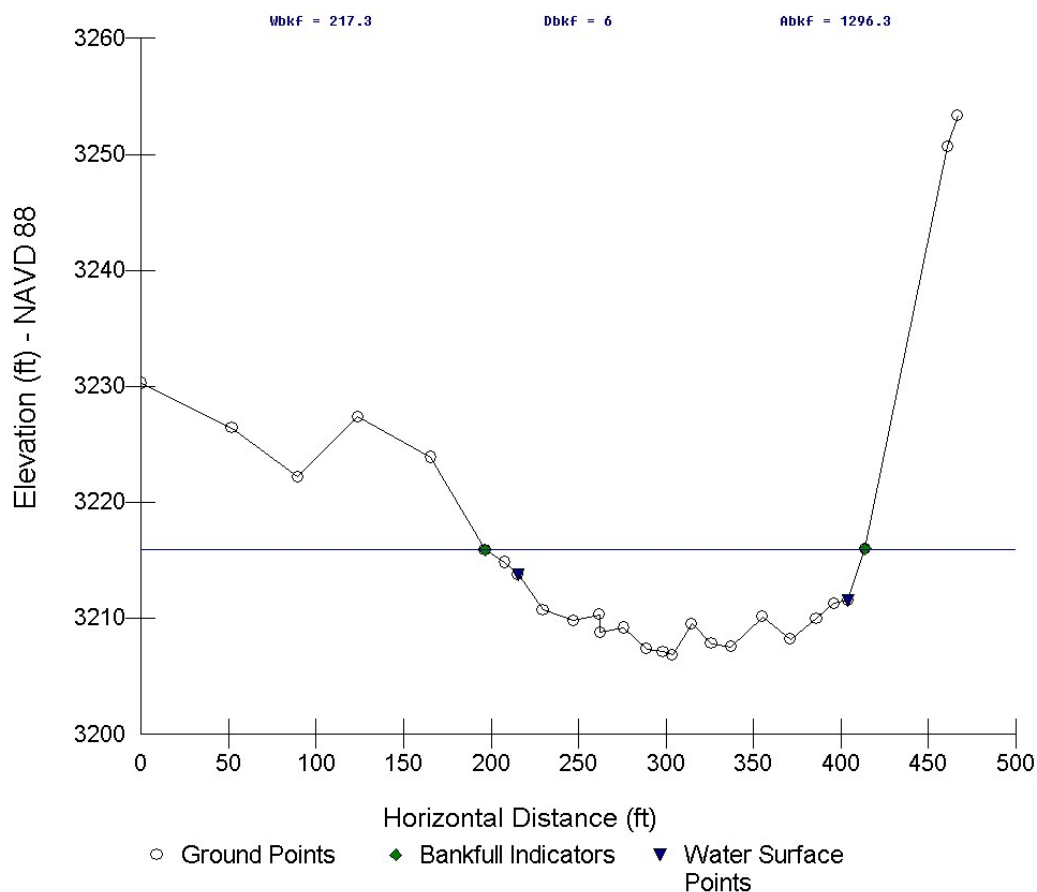
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **10**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
CFR Bandmann, Cross-Section 10 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1014	n/a	1014	n/a
Width/Depth Ratio	50.9	n/a	50.9	n/a
Bankfull Width (ft)	227	n/a	227	n/a
Mean Depth (ft)	4.5	n/a	4.5	n/a

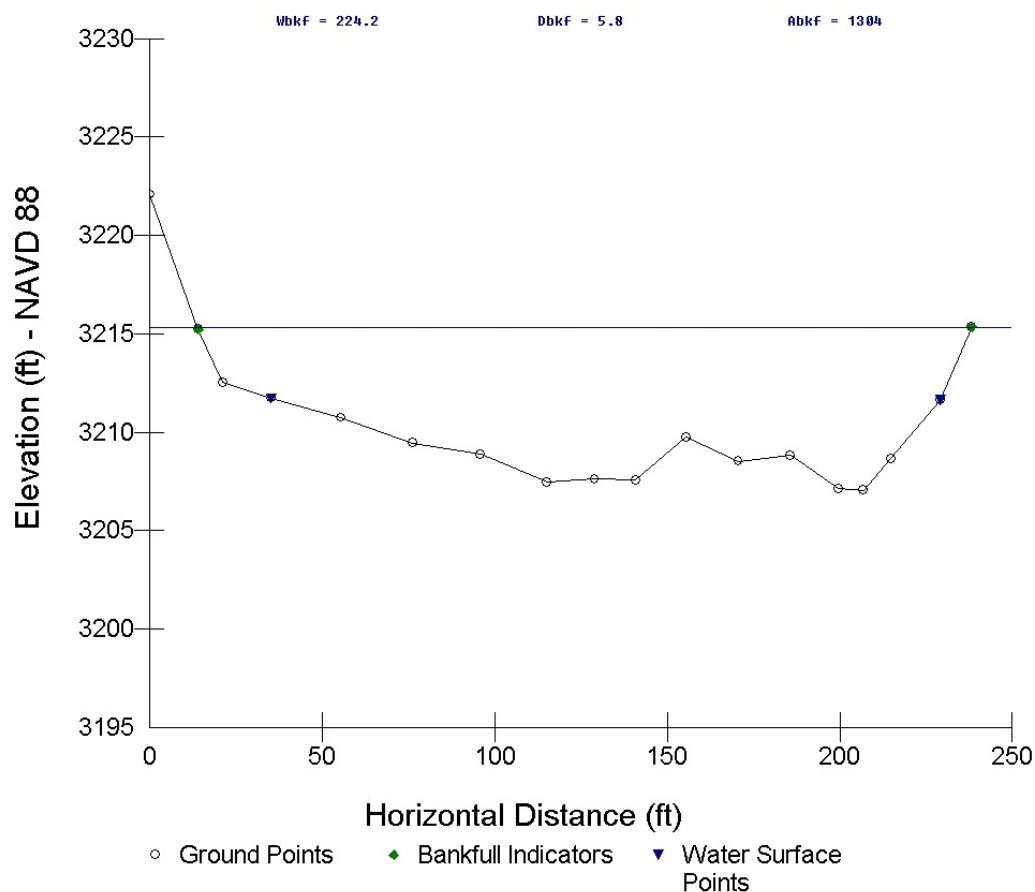
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **11**Channel Unit: **Run**

Channel Cross-Section Summary Data
 CFR Bandmann, Cross-Section 11 (Run)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1296	n/a	1296	n/a
Width/Depth Ratio	36.4	n/a	36.4	n/a
Bankfull Width (ft)	217	n/a	217	n/a
Mean Depth (ft)	6.0	n/a	6.0	n/a

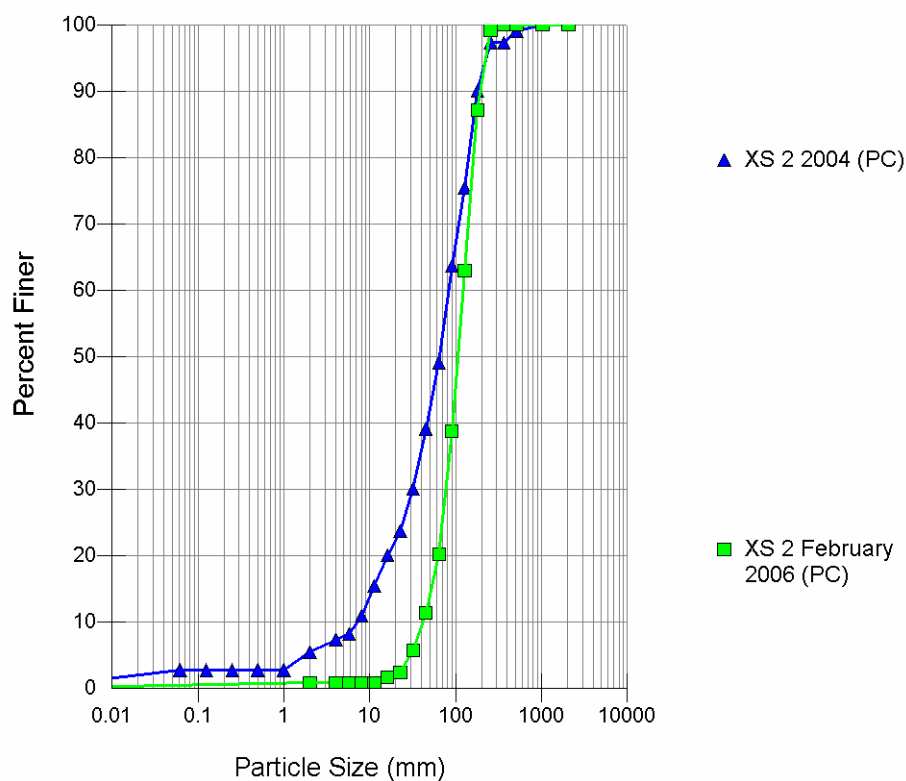
¹ Change from 2004 to 2006

Reach: **CFR Bandmann**Cross-Section: **12**Channel Unit: **Run**

Channel Cross-Section Summary Data
 CFR Bandmann, Cross-Section 12 (Run)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1304	n/a	1304	n/a
Width/Depth Ratio	38.5	n/a	38.5	n/a
Bankfull Width (ft)	224	n/a	224	n/a
Mean Depth (ft)	5.8	n/a	5.8	n/a

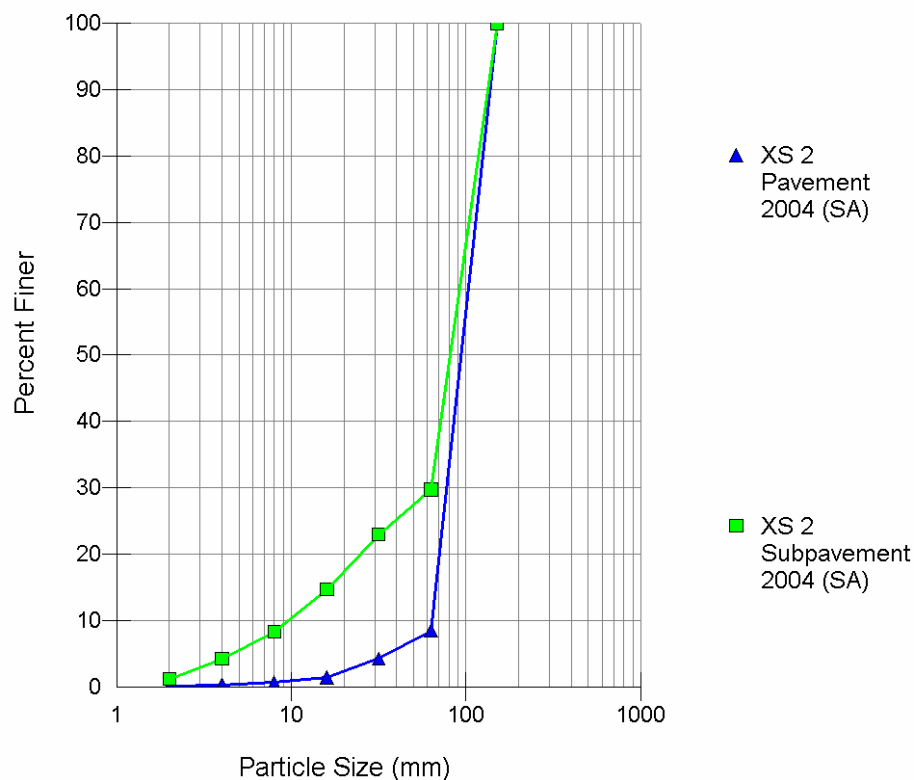
¹ Change from 2004 to 2006

Reach: CFR BandmanCross-Section: 2Channel Unit: Riffle**Wolman Pebble Count**

Wolman Pebble Count Results (mm)
CFR Bandman, Cross-Section 2. (Riffle)

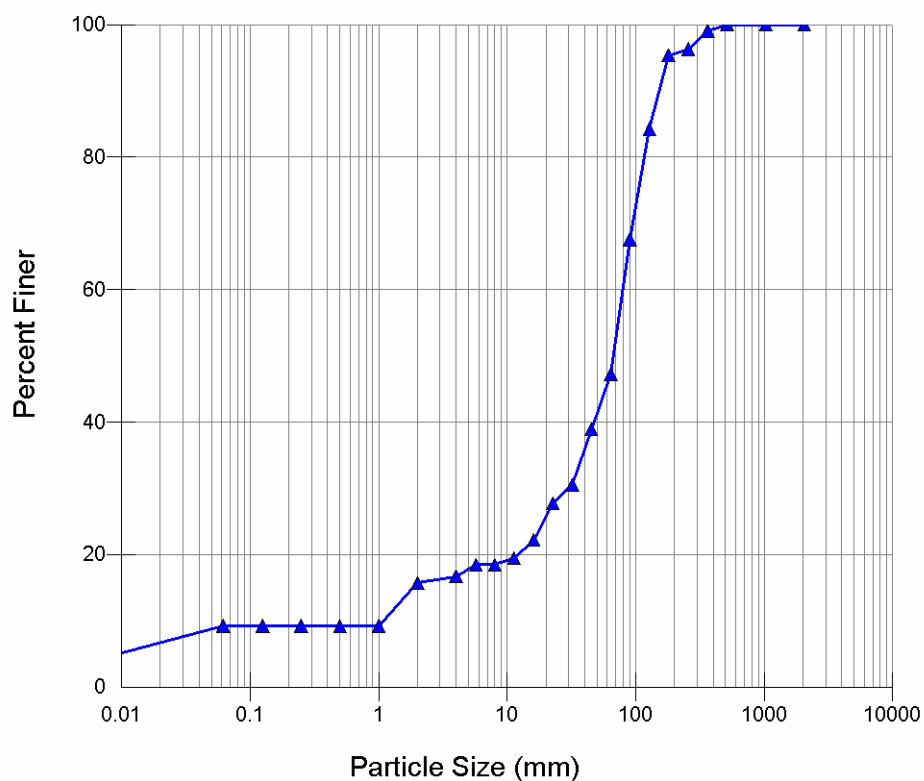
Size Class	2004	Feb 2006	Aug 2006	Mean
D16	11	55	n/a	33
D35	39	84	n/a	62
D50	66	108	n/a	87
D84	159	173	n/a	166
D95	232	230	n/a	231
D100	1024	362	n/a	693

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR Bandman, Cross-Section 2 (Riffle)

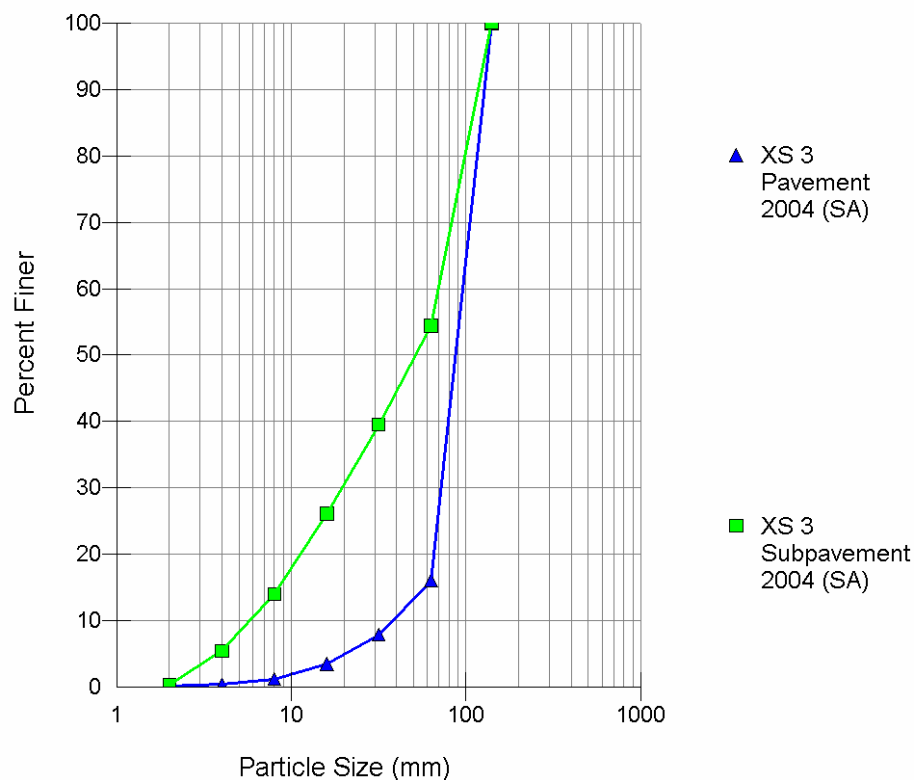
Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	70	18	n/a	n/a
D35	88	70	n/a	n/a
D50	102	88	n/a	n/a
D84	135	130	n/a	n/a
D95	145	144	n/a	n/a
D100	150	150	n/a	n/a

Reach: CFR BandmanCross-Section: 3Channel Unit: Riffle**Wolman Pebble Count**

Wolman Pebble Count Results (mm)
CFR Bandman, Cross-Section 3 (Riffle)

Size Class	2004	Feb 2006	Aug 2006	Mean
D16	2	n/a	n/a	n/a
D35	39	n/a	n/a	n/a
D50	68	n/a	n/a	n/a
D84	127	n/a	n/a	n/a
D95	178	n/a	n/a	n/a
D100	512	n/a	n/a	n/a

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
CFR Bandman, Cross-Section 3 (Riffle)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	63	9	n/a	n/a
D35	80	26	n/a	n/a
D50	94	54	n/a	n/a
D84	125	113	n/a	n/a
D95	135	132	n/a	n/a
D100	140	140	n/a	n/a

Appendix G

CFR above Missoula



REACH: CFR MISSOULA GAGE**Channel Cross-section Dimensions**

Reach	Cross-section Metric	Riffle	Pool			Glide		
		2004 Mean	Min	2004 Mean	Max	Min	2004 Mean	Max
CFR Missoula Gage	Bankfull Area (ft ²)	1065.7	1931.6	1953.3	1975.0	1270.1	1449.5	1628.8
	Width/Depth Ratio	69.3	15.1	18.1	18.3	38.2	47.2	54.2
	Mean Depth (ft)	3.9	9.4	10.4	11.4	4.6	5.6	6.5
	Max Depth (ft)	5.6	12.7	17.0	21.2	5.6	6.7	7.9
	Width (ft)	271.5	172.6	188.6	204.6	249.3	262.9	276.4

Channel Cross-section Dimensionless Ratios**2004 Data**

Dimensionless Metric	Mean
Wfpa / Wbkf	1.05
Abkf	1065.72
Dmbkf	5.57
Dbkf	3.92
Wbkf	271.54

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

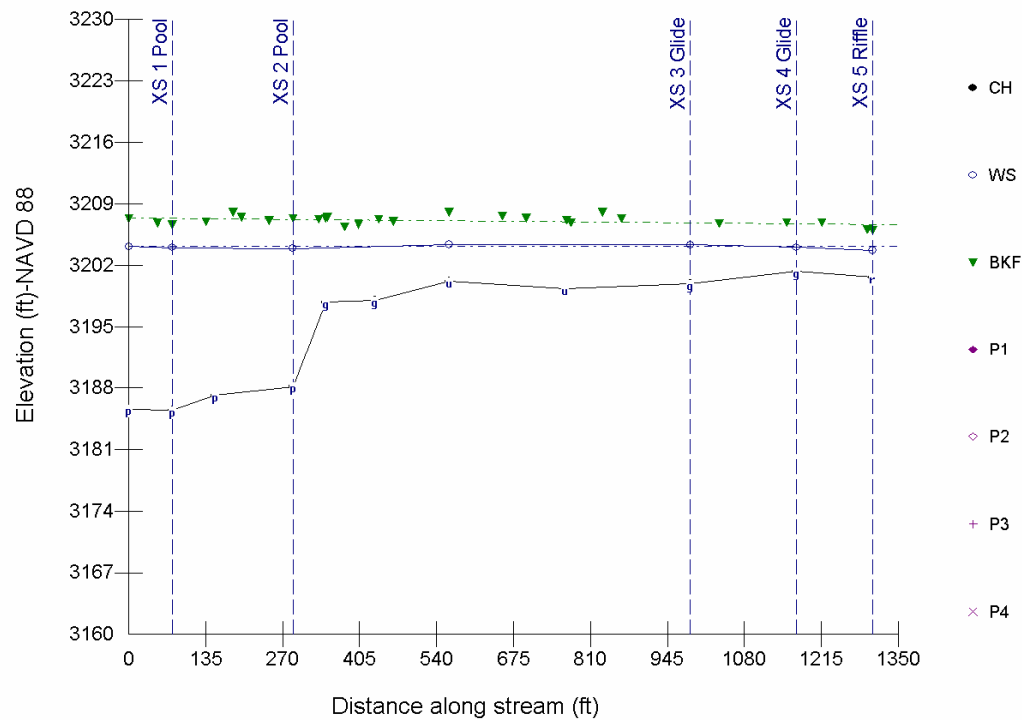
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00278	0.00278	0.00278
S pool (ft/ft)	0.00070	0.00070	0.00070
S run (ft/ft)	0.00000	0.00000	0.00000
S glide (ft/ft)	0.00167	0.00167	0.00167
P - P (ft)	0.00	0.00	0.00
P length (ft)	336.48	336.48	336.48
Dmax riffle (ft)	5.52	5.74	5.89
Dmax pool (ft)	19.71	20.86	22.01
Dmax run (ft)	0.00	0.00	0.00
Dmax glide (ft)	5.52	6.22	6.91
Low Bank Ht (ft)	5.52	5.71	5.89
Bankfull Slope (ft/ft)		0.00074	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	3.76	3.76	3.76
S pool / S bkf (ft/ft)	0.95	0.95	0.95
S run / S bkf (ft/ft)	0.00	0.00	0.00
S glide / S bkf (ft/ft)	2.26	2.26	2.26
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	1.24	1.24	1.24
Dmax riffle / D bkf (ft)	1.41	1.46	1.50
Dmax pool / D bkf (ft)	5.03	5.32	5.61
Dmax run / D bkf (ft)	0.00	0.00	0.00
Dmax glide / D bkf (ft)	1.41	1.59	1.76
Low Bank Ht / Dmax riff (ft)	0.96	0.99	1.03
Bankfull Slope (ft/ft)		0.00074	

Channel Planform Dimensions and Dimensionless Ratios

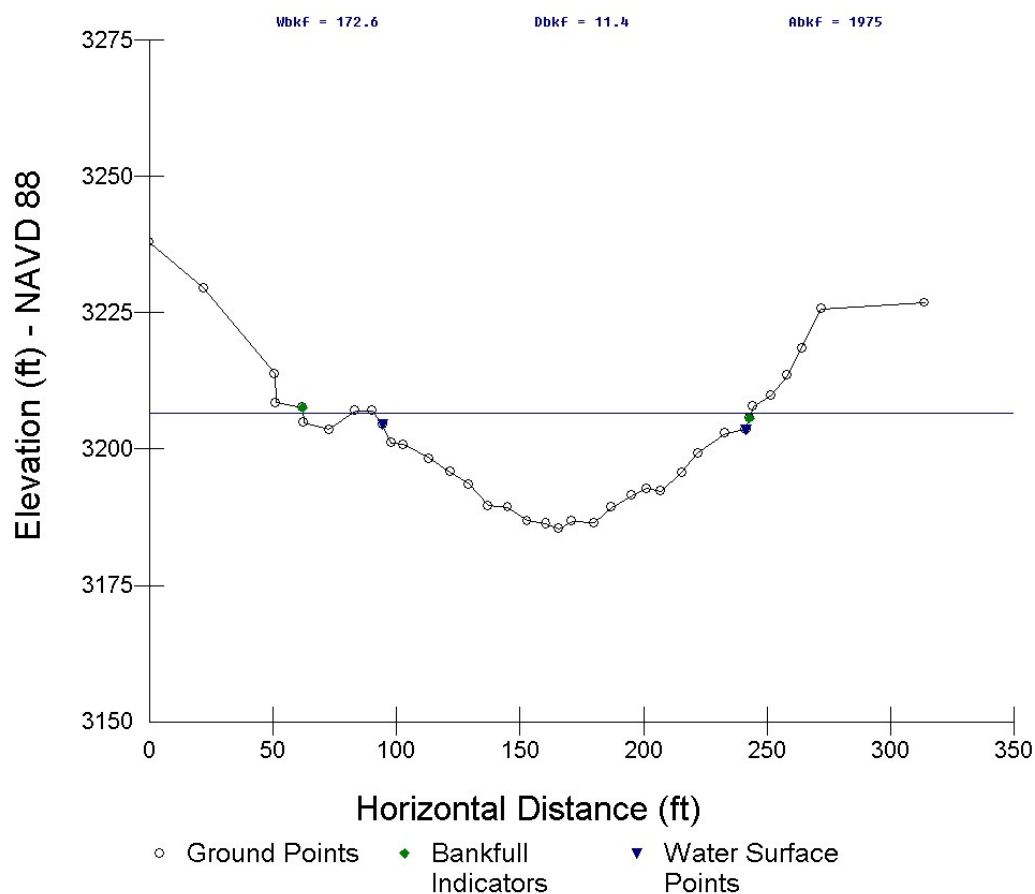
No Data

CFR above Missoula Gage 2004



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00278	0.00278	0.00278
S pool (ft/ft)	0.00070	0.00070	0.00070
S run (ft/ft)	0.00000	0.00000	0.00000
S glide (ft/ft)	0.00167	0.00167	0.00167
P - P (ft)	0.00	0.00	0.00
P length (ft)	336.48	336.48	336.48
Dmax riffle (ft)	5.52	5.74	5.89
Dmax pool (ft)	19.71	20.86	22.01
Dmax run (ft)	0.00	0.00	0.00
Dmax glide (ft)	5.52	6.22	6.91
Low Bank Ht (ft)	5.52	5.71	5.89
Bankfull Slope (ft/ft)		0.00074	

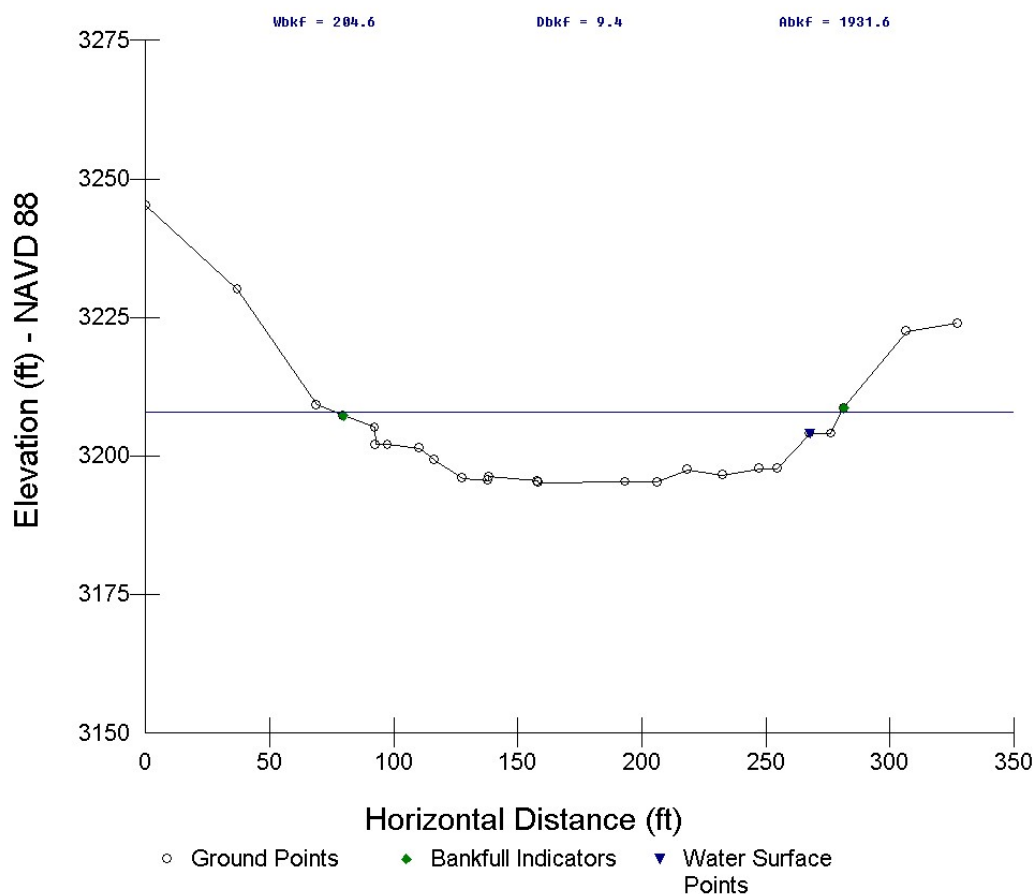
Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	3.76	3.76	3.76
S pool / S bkf (ft/ft)	0.95	0.95	0.95
S run / S bkf (ft/ft)	0.00	0.00	0.00
S glide / S bkf (ft/ft)	2.26	2.26	2.26
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	1.24	1.24	1.24
Dmax riffle / D bkf (ft)	1.41	1.46	1.50
Dmax pool / D bkf (ft)	5.03	5.32	5.61
Dmax run / D bkf (ft)	0.00	0.00	0.00
Dmax glide / D bkf (ft)	1.41	1.59	1.76
Low Bank Ht / Dmax riff (ft)	0.96	0.99	1.03
Bankfull Slope (ft/ft)		0.00074	

Reach: **CFR Missoula Gage**Cross-Section: **1**Channel Unit: **Pool**

Channel Cross-Section Summary Data
CFR Missoula Gage, Cross-Section 1 (Pool)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1975	n/a	1975	n/a
Width/Depth Ratio	15.1	n/a	15.1	n/a
Bankfull Width (ft)	173	n/a	173	n/a
Mean Depth (ft)	11.4	n/a	11.4	n/a

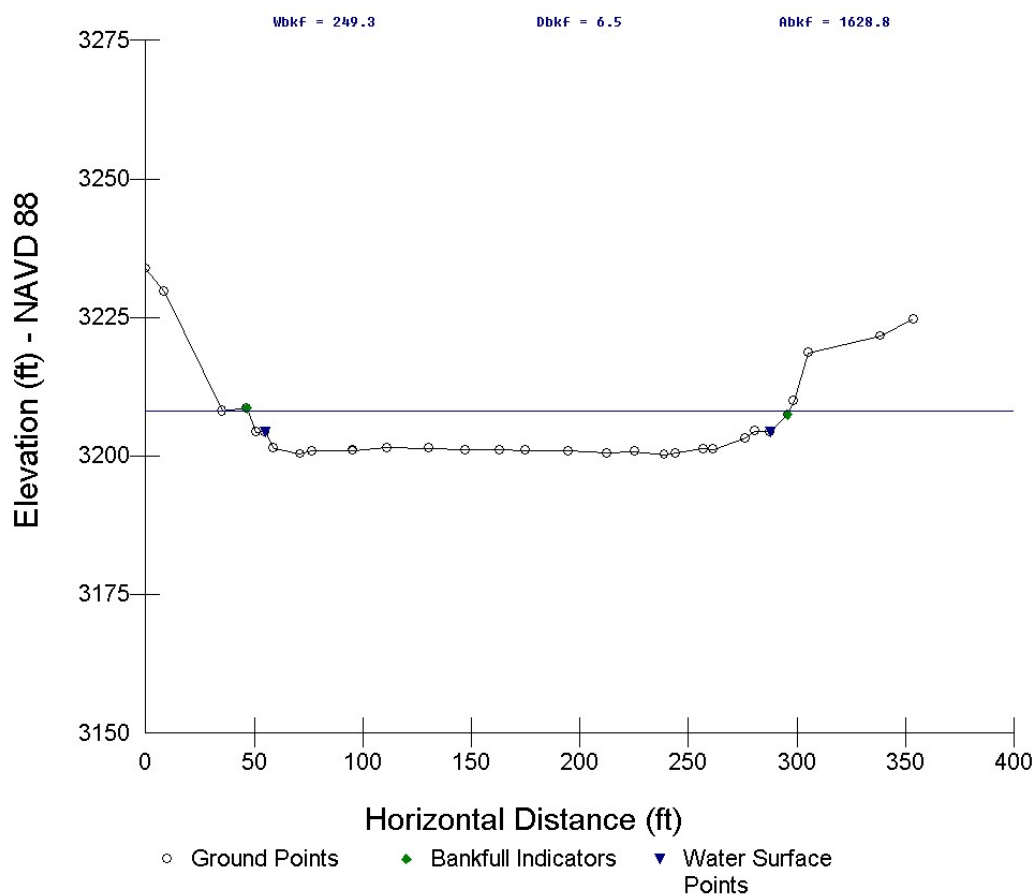
¹ Change from 2004 to 2006

Reach: **CFR Missoula Gage**Cross-Section: **2**Channel Unit: **Pool**

Channel Cross-Section Summary Data
CFR Missoula Gage, Cross-Section 2 (Pool)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1932	n/a	1932	n/a
Width/Depth Ratio	21.7	n/a	21.7	n/a
Bankfull Width (ft)	204	n/a	204	n/a
Mean Depth (ft)	9.4	n/a	9.4	n/a

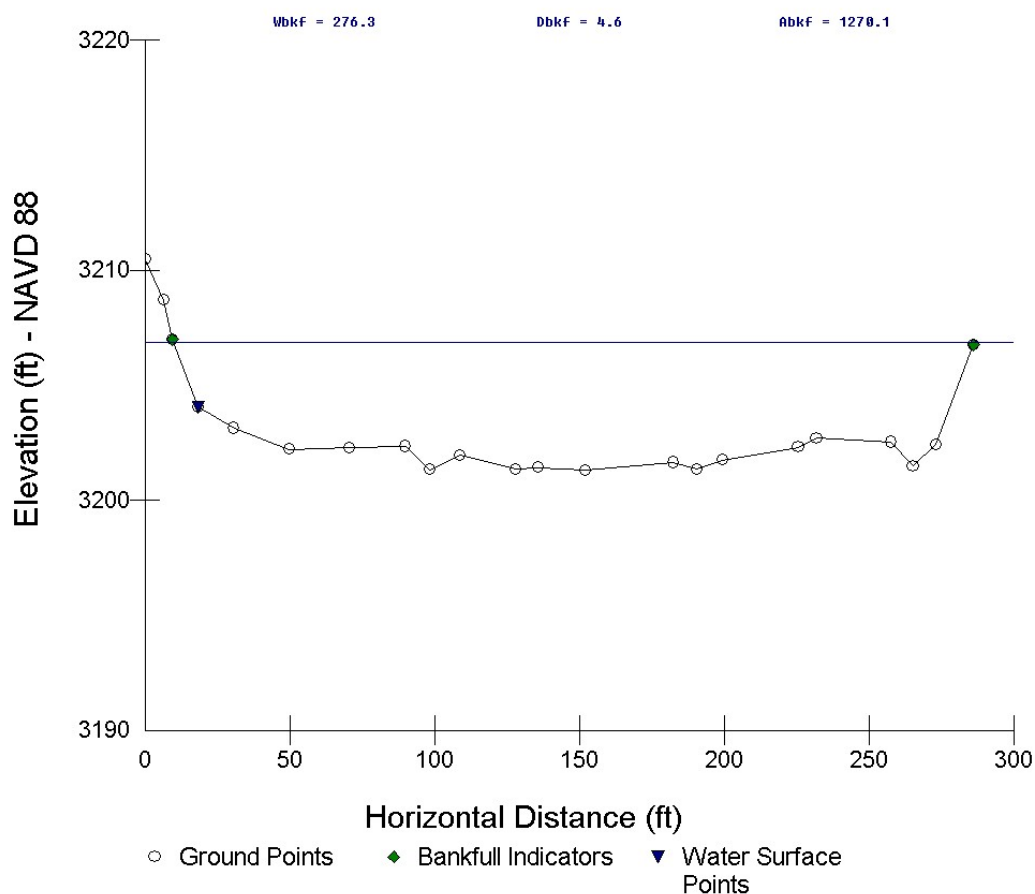
¹ Change from 2004 to 2006

Reach: **CFR Missoula Gage**Cross-Section: **3**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR Missoula Gage, Cross-Section 3 (Glide)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1629	n/a	1629	n/a
Width/Depth Ratio	38.2	n/a	38.2	n/a
Bankfull Width (ft)	249	n/a	249	n/a
Mean Depth (ft)	6.5	n/a	6.5	n/a

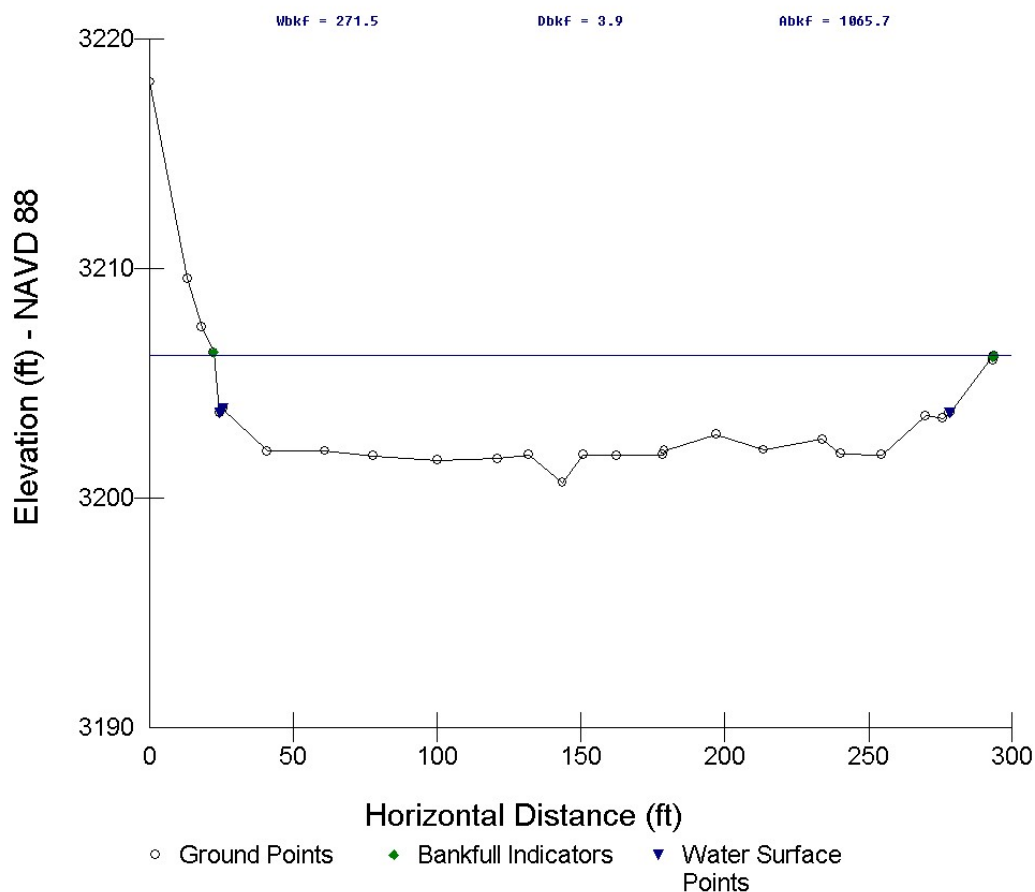
¹ Change from 2004 to 2006

Reach: **CFR Missoula Gage**Cross-Section: **4**Channel Unit: **Glide**

Channel Cross-Section Summary Data
CFR Missoula Gage, Cross-Section 4 (Glide)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1270	n/a	1270	n/a
Width/Depth Ratio	60.1	n/a	60.1	n/a
Bankfull Width (ft)	276	n/a	276	n/a
Mean Depth (ft)	4.6	n/a	4.6	n/a

¹ Change from 2004 to 2006

Reach: **CFR Missoula Gage**Cross-Section: **5**Channel Unit: **Riffle**

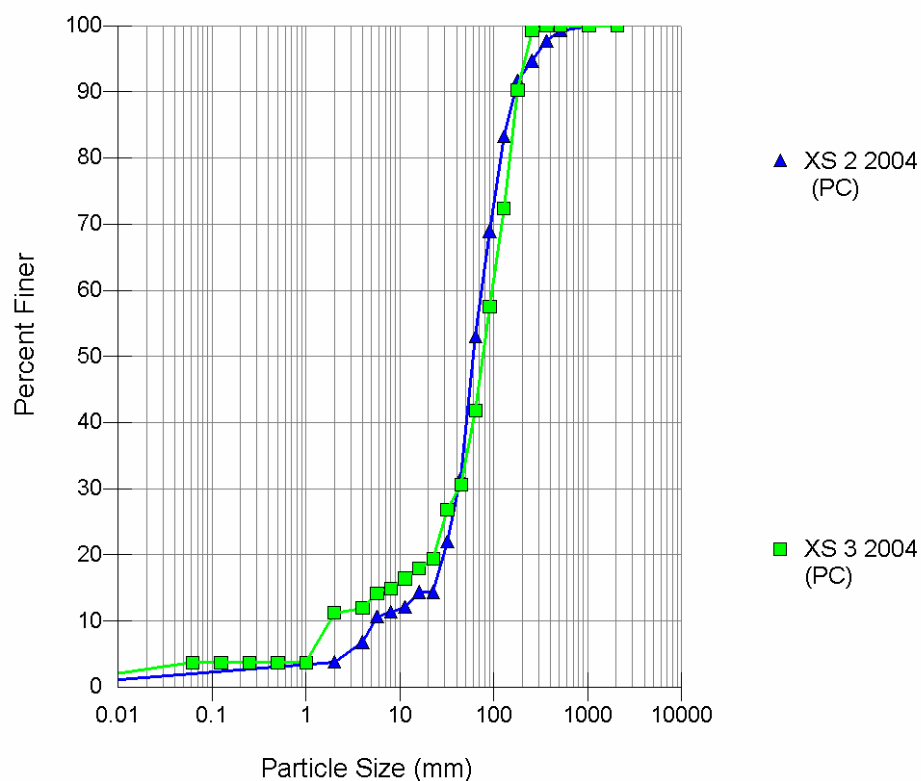
Channel Cross-Section Summary Data
CFR Missoula Gage, Cross-Section 5 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1066	n/a	1066	n/a
Width/Depth Ratio	69.3	n/a	69.3	n/a
Bankfull Width (ft)	272	n/a	272	n/a
Mean Depth (ft)	3.9	n/a	3.9	n/a

¹ Change from 2004 to 2006

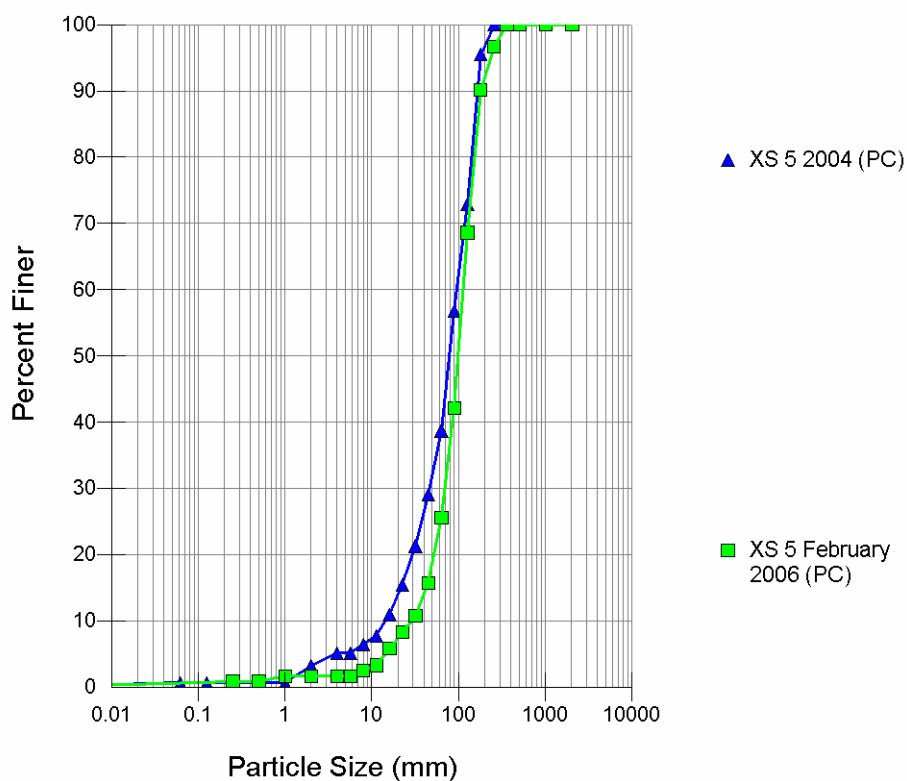
Reach: CFR Missoula Cross-Section: 2 and 3 Channel Unit: Pool and Glide

Wolman Pebble Count



Wolman Pebble Count Results (mm)
CFR Missoula, Cross-Sections 2 (Pool) and 3 (Glide)

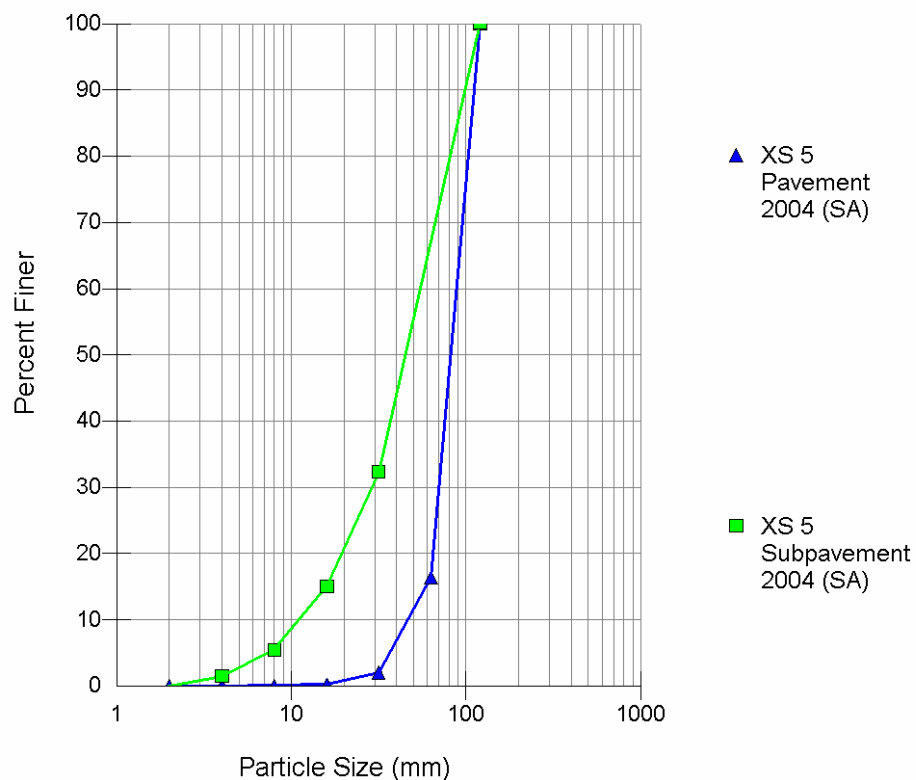
Size Class	XS 2	XS 3	Mean
D16	25	10	18
D35	48	52	50
D50	61	78	70
D84	132	162	147
D95	267	220	244
D100	1024	362	693

Reach: CFR MissoulaCross-Section: 5Channel Unit: Riffle**Wolman Pebble Count**

Wolman Pebble Count Results (mm)
CFR Missoula, Cross-Section 5 (Riffle)

Size Class	2004	Feb 2006	Aug 2006	Mean
D16	23	46	n/a	35
D35	57	79	n/a	68
D50	80	101	n/a	91
D84	154	165	n/a	160
D95	179	237	n/a	208
D100	256	362	n/a	309

Substrate Pavement and Subpavement

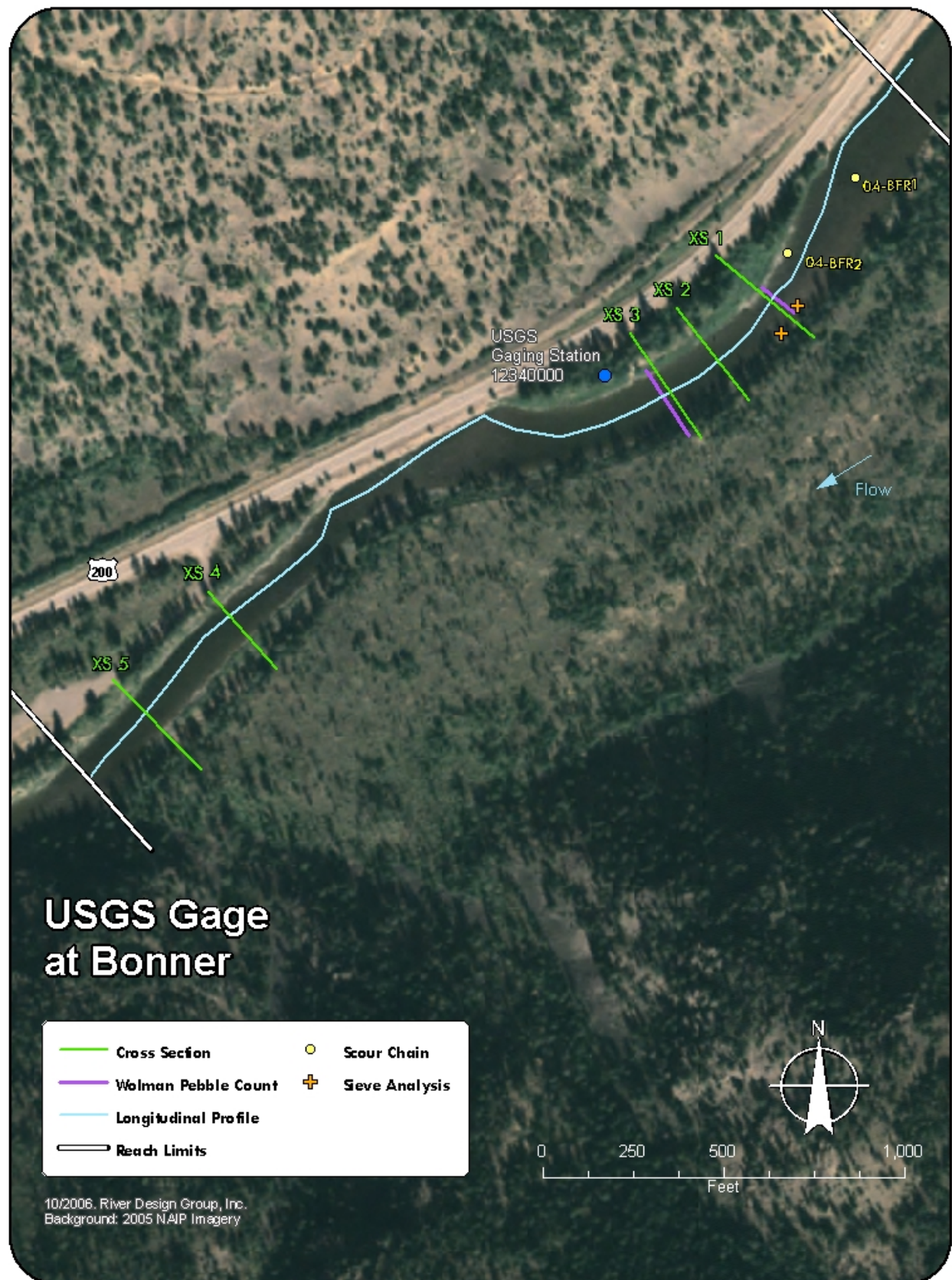


Substrate Pavement and Subpavement (mm)
CFR Missoula, Cross-Section 5 (Riffle)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	62	25	n/a	n/a
D35	76	49	n/a	n/a
D50	86	66	n/a	n/a
D84	110	103	n/a	n/a
D95	117	115	n/a	n/a
D100	120	120	n/a	n/a

Appendix H

BFR near Bonner



REACH: BFR BONNER**Channel Cross-section Dimensions**

		Riffle							
		Min	2004 Mean	Max	Feb 2006 Mean	Min	Aug 2006 Mean Max		Total Average
Reach	Cross-section Metric								
BFR Bonner	Bankfull Area (ft ²)	661.5	786.6	911.6	657.0	665.75	846.0	946.06	763.2
	Width/Depth Ratio	39.6	46.4	47.6	47.54	39.4	47.3	49.5	47.1
	Mean Depth (ft)	3.7	4.1	4.5	3.72	3.67	4.22	4.61	4.0
	Max Depth (ft)	5.0	5.8	6.6	5.09	5.12	6.55	7.58	5.8
	Width (ft)	177.6	190.6	203.6	176.86	181.57	199.5	211.49	189.0

Reach	Cross-section Metric	Run
		2004 Mean
BFR Bonner	Bankfull Area (ft ²)	1034.2
	Width/Depth Ratio	45.2
	Mean Depth (ft)	4.78
	Max Depth (ft)	8.64
	Width (ft)	216.2

Reach	Cross-section Metric	Glide						
		Min	2004 Mean	Max	Min	Aug 2006 Mean	Max	Total Average
BFR Bonner	Bankfull Area (ft ²)	862.1	939.64	1017.2	835.7	938.1	1040.5	938.9
	Width/Depth Ratio	32.7	35.4	35.6	31.0	34.5	35.7	35.0
	Mean Depth (ft)	4.9	5.15	5.4	4.84	5.21	5.57	5.2
	Max Depth (ft)	7.2	7.54	7.9	7.05	7.34	7.63	7.4
	Width (ft)	175.4	182.48	189.6	172.6	179.76	186.9	181.1

Channel Cross-section Dimensionless Ratios

2004 Data

Dimensionless Metric	Min	Mean	Max
Wfpa / Wbkf	1.30	1.30	1.40
Abkf	661.50	786.60	911.60
Dmbkf	5.00	5.80	6.60
Dbkf	3.70	4.10	4.50
Wbkf	177.60	190.60	203.60

2006 Data

Dimensionless Metric	Min	Mean	Max
Wfpa / Wbkf	1.12	1.19	1.26
Abkf	665.75	793.61	921.47
Dmbkf	5.12	6.35	7.58
Dbkf	3.67	4.24	4.81
Wbkf	181.57	186.65	191.73

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00592	0.00640	0.00688
S pool (ft/ft)	0.00000	0.00000	0.00000
S run (ft/ft)	0.00090	0.00090	0.00090
S glide (ft/ft)	0.00103	0.00172	0.00258
P - P (ft)	0.00	0.00	0.00
P length (ft)	0.00	0.00	0.00
Dmax riffle (ft)	3.95	5.44	7.06
Dmax pool (ft)	0.00	0.00	0.00
Dmax run (ft)	7.90	7.90	7.90
Dmax glide (ft)	5.32	6.94	8.06
Low Bank Ht (ft)	3.79	3.98	4.16
Bankfull Slope (ft/ft)		0.00312	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.90	2.05	2.21
S pool / S bkf (ft/ft)	0.00	0.00	0.00
S run / S bkf (ft/ft)	0.29	0.29	0.29
S glide / S bkf (ft/ft)	0.33	0.55	0.83
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	0.00	0.00	0.00
Dmax riffle / D bkf (ft)	0.96	1.32	1.72
Dmax pool / D bkf (ft)	0.00	0.00	0.00
Dmax run / D bkf (ft)	1.92	1.92	1.92
Dmax glide / D bkf (ft)	1.29	1.69	1.96
Low Bank Ht / Dmax riff (ft)	0.70	0.73	0.76
Bankfull Slope (ft/ft)		0.00312	

2006 Data

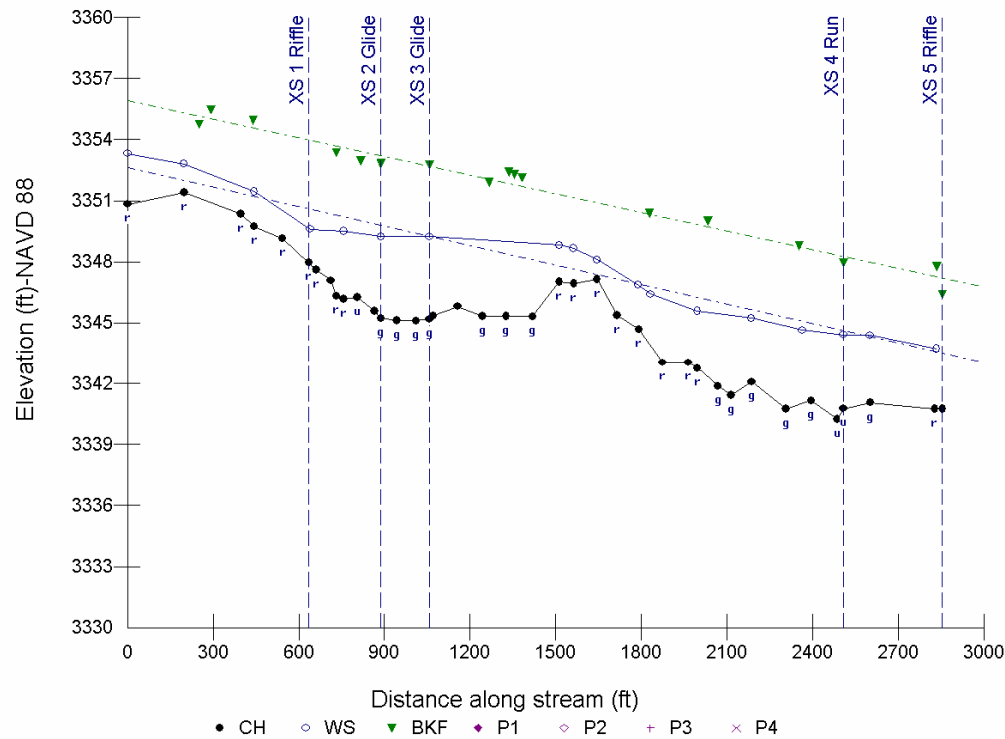
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00665	0.00685	0.00704
S pool (ft/ft)	0.00000	0.00000	0.00000
S run (ft/ft)	0.00000	0.00000	0.00000
S glide (ft/ft)	0.00078	0.00176	0.00234
P - P (ft)	0.00	0.00	0.00
P length (ft)	0.00	0.00	0.00
Dmax riffle (ft)	3.96	5.81	6.93
Dmax pool (ft)	0.00	0.00	0.00
Dmax run (ft)	0.00	0.00	0.00
Dmax glide (ft)	5.29	6.63	8.10
Low Bank Ht (ft)	3.84	3.84	3.84
Bankfull Slope (ft/ft)		0.00319	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	2.08	2.15	2.21
S pool / S bkf (ft/ft)	0.00	0.00	0.00
S run / S bkf (ft/ft)	0.00	0.00	0.00
S glide / S bkf (ft/ft)	0.24	0.55	0.73
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	0.00	0.00	0.00
Dmax riffle / D bkf (ft)	0.93	1.37	1.63
Dmax pool / D bkf (ft)	0.00	0.00	0.00
Dmax run / D bkf (ft)	0.00	0.00	0.00
Dmax glide / D bkf (ft)	1.25	1.56	1.91
Low Bank Ht / Dmax riff (ft)	0.66	0.66	0.66
Bankfull Slope (ft/ft)		0.00319	

Channel Planform Dimensions and Dimensionless Ratios

No Data

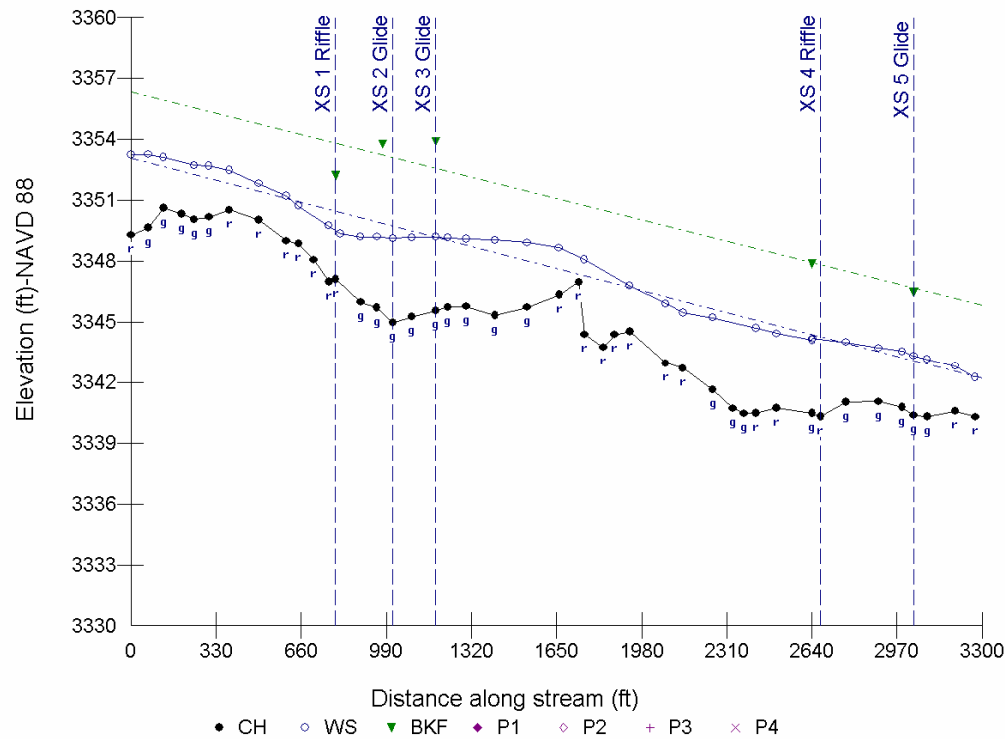
BFR near Bonner 2004



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00592	0.00640	0.00688
S pool (ft/ft)	0.00000	0.00000	0.00000
S run (ft/ft)	0.00090	0.00090	0.00090
S glide (ft/ft)	0.00103	0.00172	0.00258
P - P (ft)	0.00	0.00	0.00
P length (ft)	0.00	0.00	0.00
Dmax riffle (ft)	3.95	5.44	7.06
Dmax pool (ft)	0.00	0.00	0.00
Dmax run (ft)	7.90	7.90	7.90
Dmax glide (ft)	5.32	6.94	8.06
Low Bank Ht (ft)	3.79	3.98	4.16
Bankfull Slope (ft/ft)		0.00312	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	1.90	2.05	2.21
S pool / S bkf (ft/ft)	0.00	0.00	0.00
S run / S bkf (ft/ft)	0.29	0.29	0.29
S glide / S bkf (ft/ft)	0.33	0.55	0.83
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	0.00	0.00	0.00
Dmax riffle / D bkf (ft)	0.96	1.32	1.72
Dmax pool / D bkf (ft)	0.00	0.00	0.00
Dmax run / D bkf (ft)	1.92	1.92	1.92
Dmax glide / D bkf (ft)	1.29	1.69	1.96
Low Bank Ht / Dmax riff (ft)	0.70	0.73	0.76
Bankfull Slope (ft/ft)		0.00312	

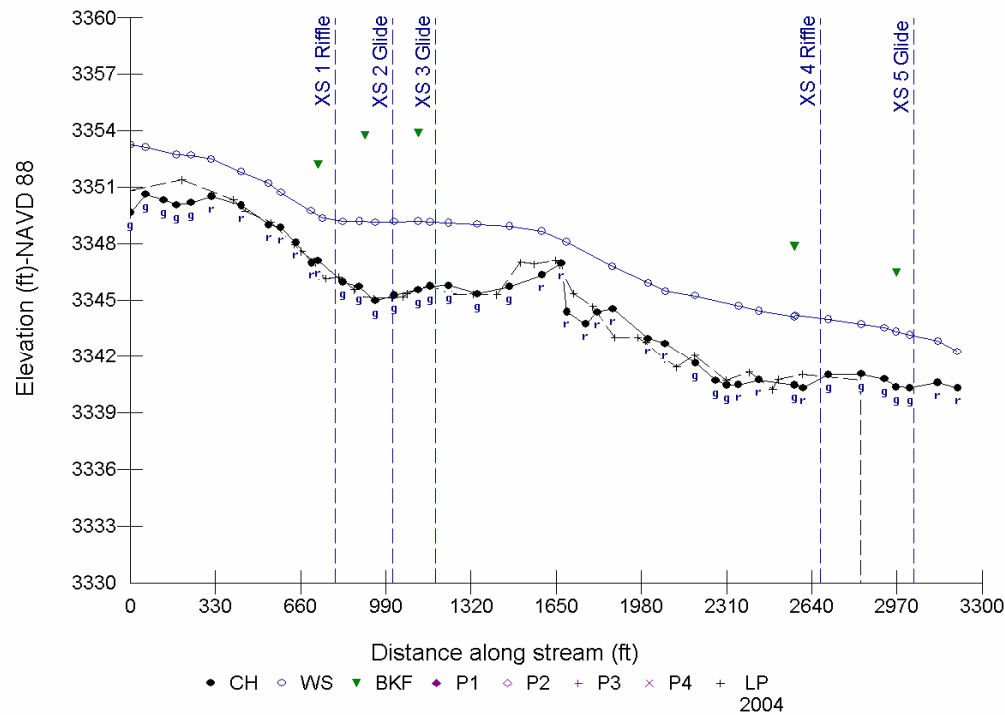
BFR near Bonner 2006



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00665	0.00685	0.00704
S pool (ft/ft)	0.00000	0.00000	0.00000
S run (ft/ft)	0.00000	0.00000	0.00000
S glide (ft/ft)	0.00078	0.00176	0.00234
P - P (ft)	0.00	0.00	0.00
P length (ft)	0.00	0.00	0.00
Dmax riffle (ft)	3.96	5.81	6.93
Dmax pool (ft)	0.00	0.00	0.00
Dmax run (ft)	0.00	0.00	0.00
Dmax glide (ft)	5.29	6.63	8.10
Low Bank Ht (ft)	3.84	3.84	3.84
Bankfull Slope (ft/ft)		0.00319	

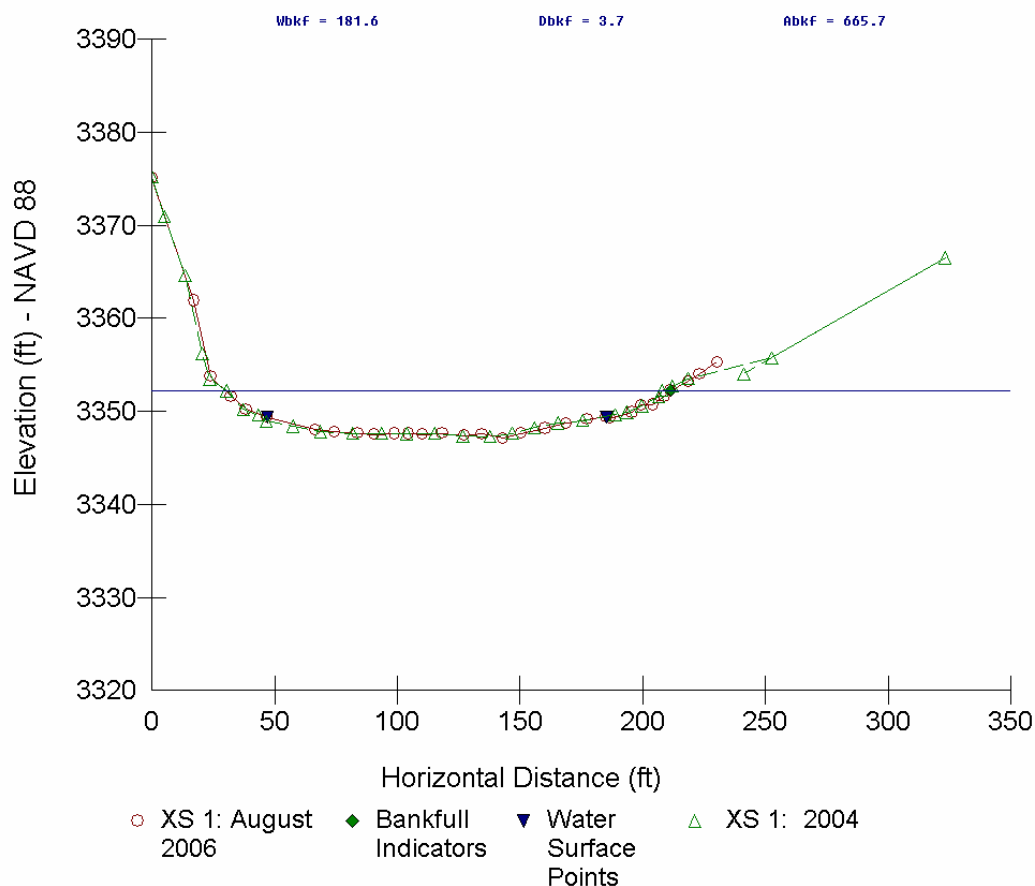
Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	2.08	2.15	2.21
S pool / S bkf (ft/ft)	0.00	0.00	0.00
S run / S bkf (ft/ft)	0.00	0.00	0.00
S glide / S bkf (ft/ft)	0.24	0.55	0.73
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	0.00	0.00	0.00
Dmax riffle / D bkf (ft)	0.93	1.37	1.63
Dmax pool / D bkf (ft)	0.00	0.00	0.00
Dmax run / D bkf (ft)	0.00	0.00	0.00
Dmax glide / D bkf (ft)	1.25	1.56	1.91
Low Bank Ht / Dmax riff (ft)	0.66	0.66	0.66
Bankfull Slope (ft/ft)		0.00319	

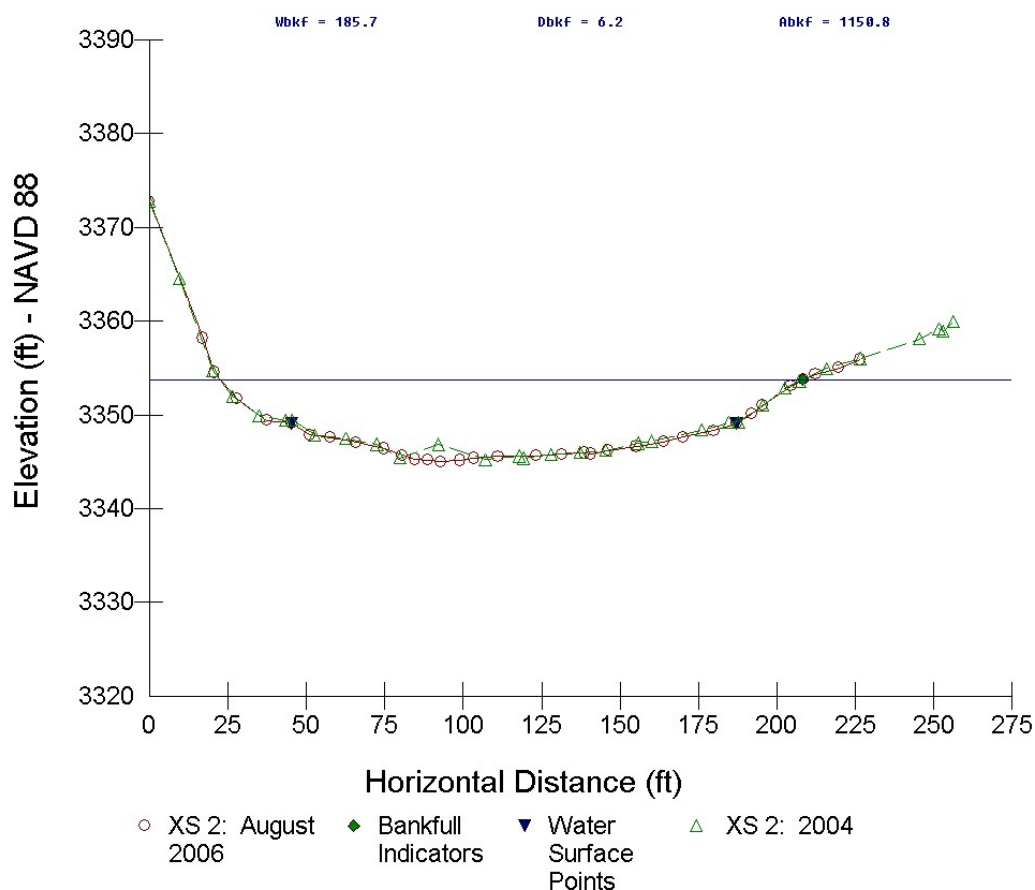
BFR near Bonner 2004 and 2006



Profile Dimensions Metric	2004 Mean	2006 Mean	Difference (+/-)
S riffle (ft/ft)	0.00640	0.00685	0.00045
S pool (ft/ft)	0.00000	0	0.00000
S run (ft/ft)	0.00090	0	-0.00090
S glide (ft/ft)	0.00172	0.00176	0.00004
P - P (ft)	0.00	0.00	0.00
P length (ft)	0.00	0.00	0.00
Dmax riffle (ft)	5.44	5.81	0.37
Dmax pool (ft)	0.00	0.00	0.00
Dmax run (ft)	7.90	0.00	-7.90
Dmax glide (ft)	6.94	6.63	-0.31
Low Bank Ht (ft)	3.98	3.84	-0.14000
Bankfull Slope (ft/ft)	0.00312	0.00319	0.00007

Profile Dimensionless Metric	2004 Mean	2006 Mean	Difference (+/-)
S riffle / S bkf (ft/ft)	2.05	2.15	0.10
S pool / S bkf (ft/ft)	0.00	0.00	0.00
S run / S bkf (ft/ft)	0.29	0.00	-0.29
S glide / S bkf (ft/ft)	0.55	0.55	0.00
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	0.00	0.00	0.00
Dmax riffle / D bkf (ft)	1.32	1.37	0.05
Dmax pool / D bkf (ft)	0.00	0.00	0.00
Dmax run / D bkf (ft)	1.92	0.00	-1.92
Dmax glide / D bkf (ft)	1.69	1.56	-0.13
Low Bank Ht / Dmax riff (ft)	0.73	0.66	-0.07
Bankfull Slope (ft/ft)	0.00312	0.00319	0.00

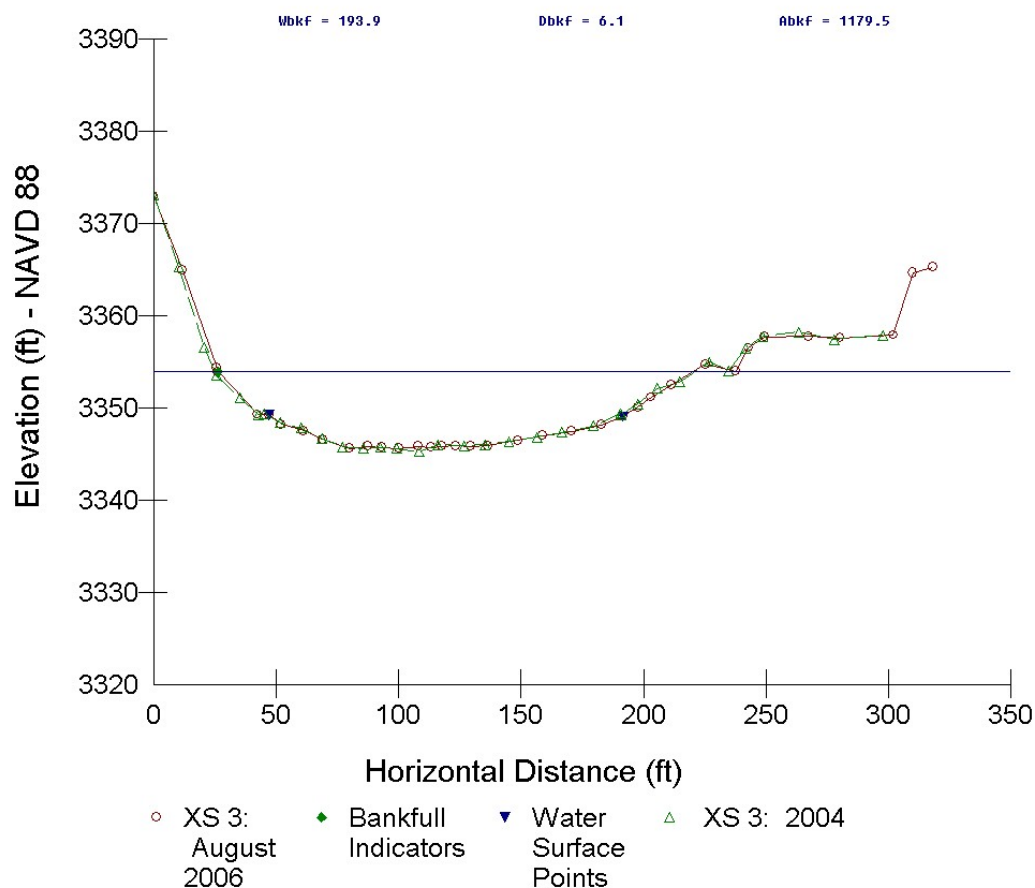
Reach: **BFR near Bonner**Cross-Section: **1**Channel Unit: **Riffle**

Reach: **BFR near Bonner**Cross-Section: **2**Channel Unit: **Glide**

Channel Cross-Section Summary Data
BFR near Bonner, Cross-Section 2 (Glide)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	862	904	883	-3.0
Width/Depth Ratio	35.6	34	34.8	0.3
Bankfull Width (ft)	175	175	175	-1.1
Mean Depth (ft)	4.9	5.2	5.1	-2.0

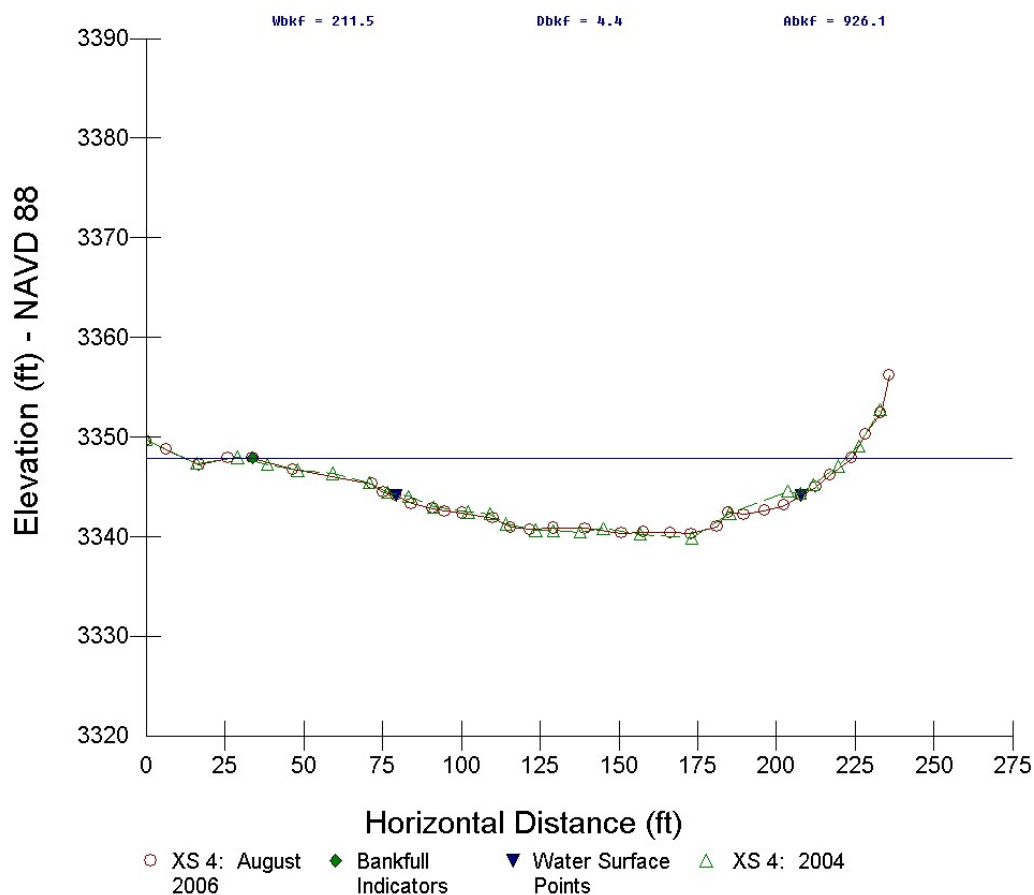
¹ Change from 2004 to 2006

Reach: **BFR near Bonner**Cross-Section: **3**Channel Unit: **Glide**

Channel Cross-Section Summary Data
BFR near Bonner, Cross-Section 3 (Glide)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1017	1041	1029	+2.4
Width/Depth Ratio	35.3	33.6	34.5	-4.8
Bankfull Width (ft)	190	187	188.5	-1.6
Mean Depth (ft)	5.4	5.6	5.5	+3.7

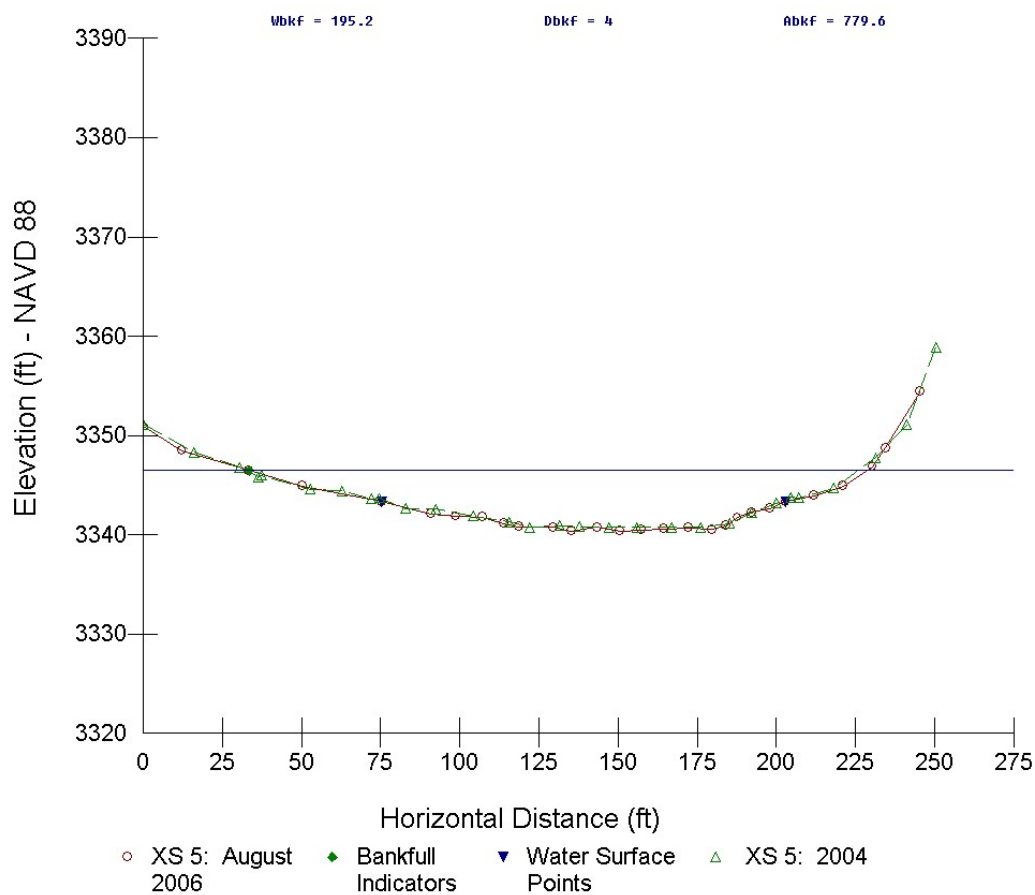
¹ Change from 2004 to 2006

Reach: **BFR near Bonner**Cross-Section: **4**Channel Unit: **Run**

Channel Cross-Section Summary Data
 BFR near Bonner, Cross-Section 4 (Run)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	1079	1068	1073.5	-1.1
Width/Depth Ratio	43.3	44.1	43.7	1.8
Bankfull Width (ft)	216	217.2	216.6	+0.5
Mean Depth (ft)	5.0	4.9	5.0	-2.0

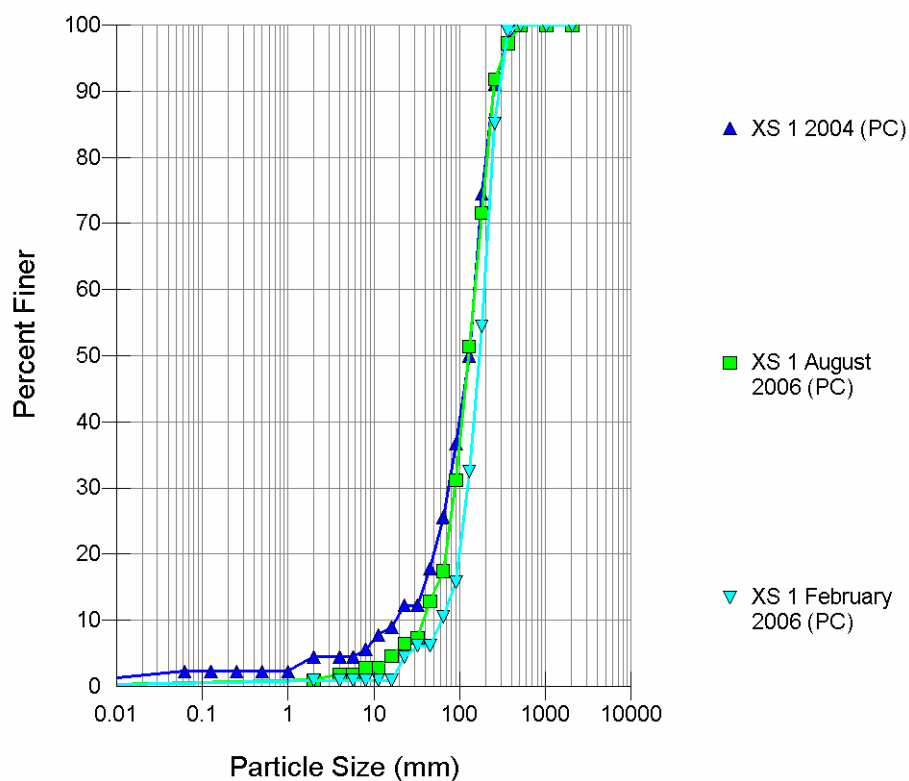
¹ Change from 2004 to 2006

Reach: **BFR near Bonner**Cross-Section: **5**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
BFR near Bonner, Cross-Section 5 (Riffle)

	2004	Aug 2006	Mean	Percent Change ¹
Bankfull Area (ft ²)	912	845	879	-7.5
Width/Depth Ratio	45.4	47.5	46.5	+4.6
Bankfull Width (ft)	204	200.3	202	-2.0
Mean Depth (ft)	4.5	4.2	4.4	-6.7

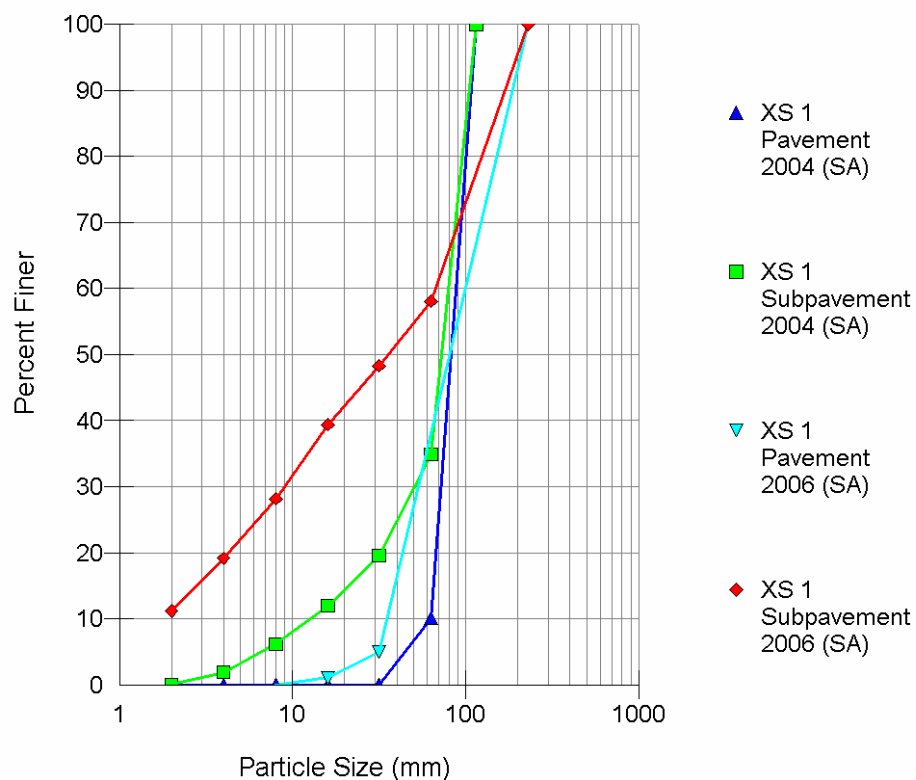
¹ Change from 2004 to 2006

Reach: **BFR near Bonner**Cross-Section: **1** Channel Unit: **Riffle****Wolman Pebble Count**

Wolman Pebble Count Results (mm)
BFR near Bonner, Cross-Section 1.

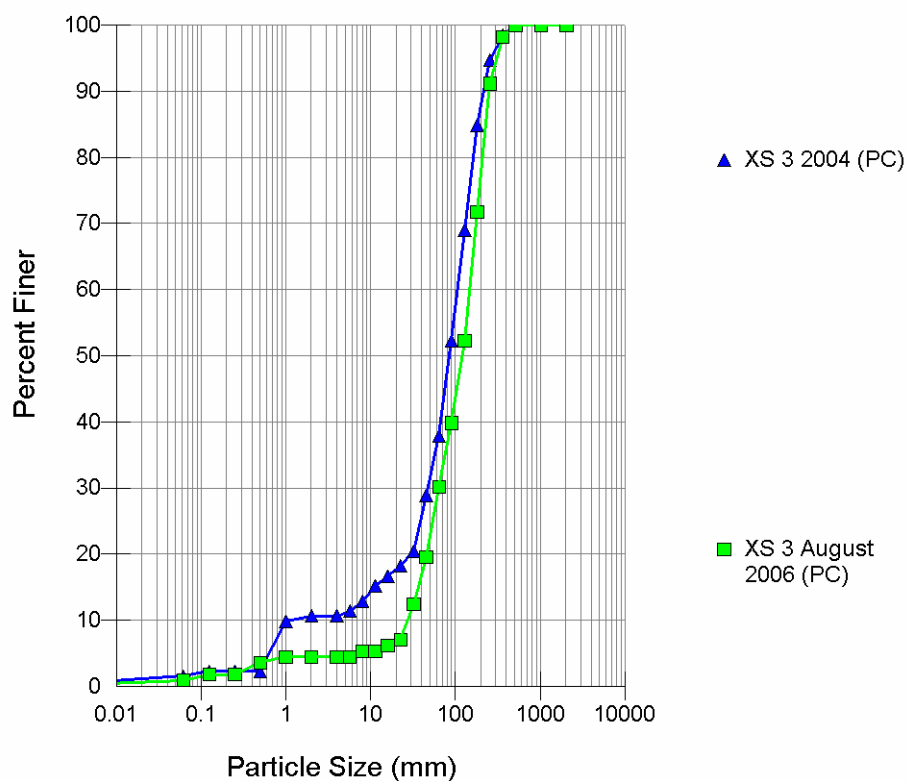
Size Class	2004	Feb 2006	Aug 2006	Mean
D16	41	91	58	63
D35	86	134	97	106
D50	128	170	125	141
D84	224	253	227	235
D95	318	331	319	323
D100	512	512	512	512

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
BFR near Bonner, Cross-Section 1 (Riffle)

Size Class	2004 Pavement	2004 Subpavement	2006 Pavement	2006 Subpavement
D16	66	24	84	3
D35	77	63	117	13
D50	86	75	143	37
D84	106	102	202	166
D95	112	111	221	210
D100	115	115	230	230

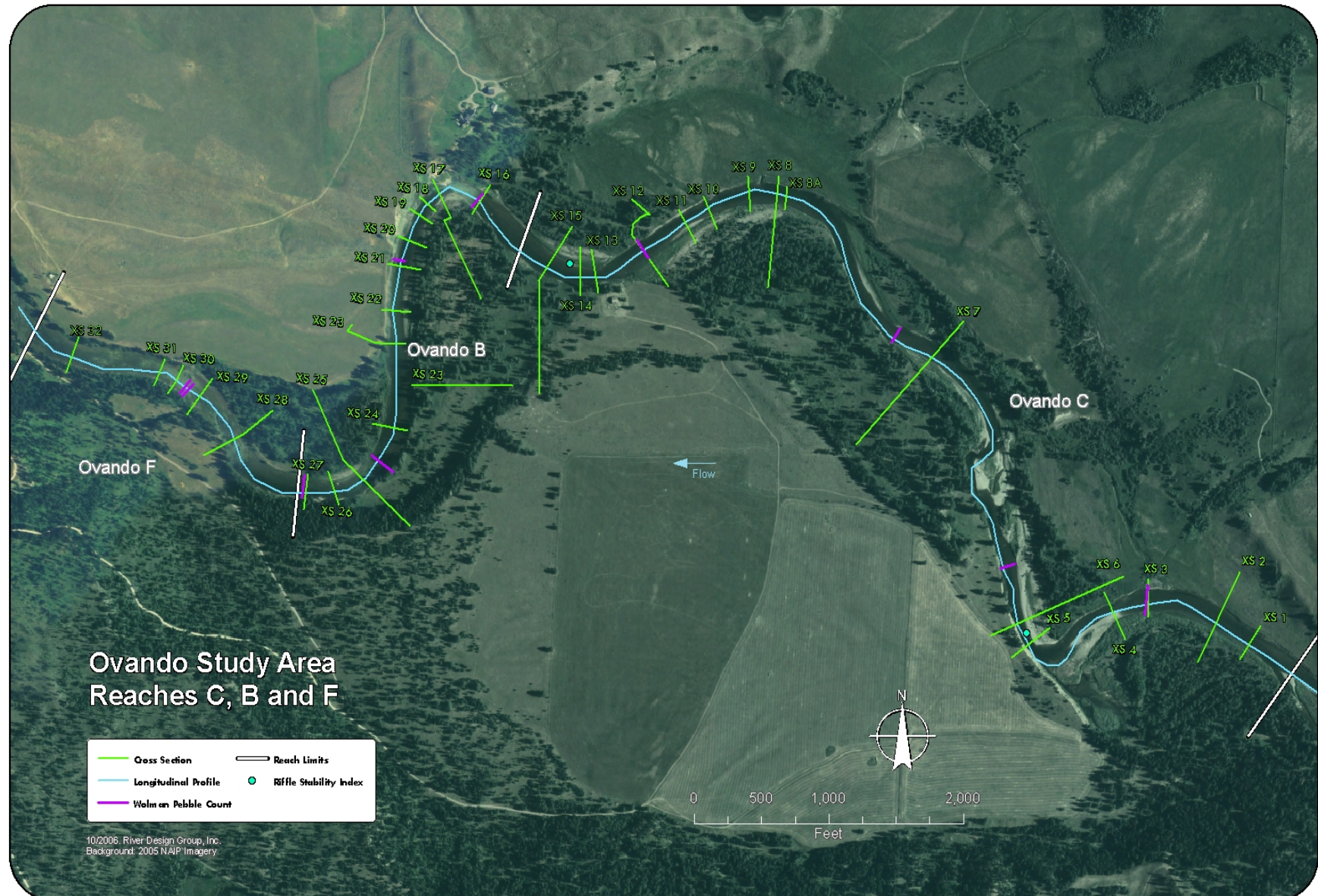
Reach: **BFR near Bonner**Cross-Section: **3** Channel Unit: **Glide****Wolman Pebble Count**

Wolman Pebble Count Results (mm)
BFR near Bonner, Cross-Section 3 (Glide)

Size Class	2004	Feb 2006	Aug 2006	Mean
D16	14	n/a	39	27
D35	58	n/a	77	68
D50	86	n/a	121	104
D84	177	n/a	228	203
D95	264	n/a	314	189
D100	512	n/a	512	512

Appendix I

BFR at Ovando C



REACH: BFR OVANDO C**Channel Cross-section Dimensions**

Reach	Cross-section Metric	Riffle 2004			Run 2004			Pool 2004			Glide 2004		
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	min	mean	max
BFR Ovando C	Bankfull Area (ft ²)	422.6	494.16	552.3	397.2	5145.0	615.9	429.1	517.5	584.3	465.7	566.4	711.8
	Width/Depth Ratio	39.1	52.7	53.7	29.0	45.3	50.6	31.5	38.2	34.5	31.0	54.7	40.3
	Mean Depth (ft)	2.6	3.07	3.5	2.6	3.39	4.6	3.5	3.68	3.9	3.0	3.25	3.9
	Max Depth (ft)	3.8	4.39	5.0	4.4	6.08	6.9	6.0	7	7.6	4.0	4.98	6.6
	Width (ft)	137.5	161.65	184.4	133.5	153.6	172.8	121.6	140.4	151.4	120.2	177.8	233.1

Channel Cross-section Dimensionless Ratios**2004 Data**

Dimensionless Metric	Min	Mean	Max
Wfpa / Wbkf	1.13	2.05	4.54
Abkf	422.64	494.16	552.33
Dmbkf	3.82	4.39	4.96
Dbkf	2.56	3.07	3.52
Wbkf	137.49	161.65	184.42
Pool Area / Abkf	0.87	1.05	1.18
Max Pool Depth / Dbkf	1.96	2.28	2.48
Mean Pool Depth / Dbkf	1.15	1.20	1.26
Pool Width / Wbkf	0.75	0.87	0.94
Run Area / Abkf	0.80	1.04	1.25
Max Run Depth / Dbkf	1.43	1.98	2.25
Mean Run Depth / Dbkf	0.86	1.10	1.50
Run Width / Wbkf	0.83	0.95	1.07
Glide Area / Abkf	0.94	1.15	1.44
Max Glide Depth / Dbkf	1.31	1.62	2.16
Mean Glide Depth / Dbkf	0.97	1.06	1.26
Glide Width / Wbkf	0.74	1.10	1.44

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

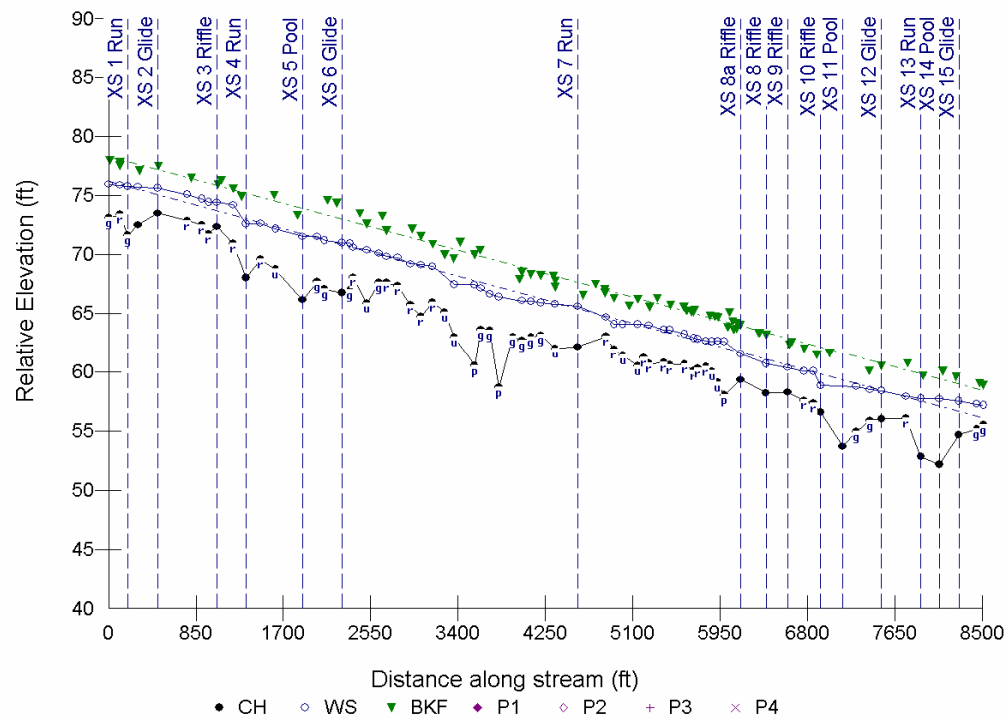
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00189	0.00247	0.00346
S pool (ft/ft)	0.00015	0.00031	0.00039
S run (ft/ft)	0.00106	0.00704	0.01254
S glide (ft/ft)	0.00049	0.00133	0.00193
P - P (ft)	911.54	1543.81	2332.46
P length (ft)	223.42	327.68	455.77
Dmax riffle (ft)	3.55	4.66	5.2
Dmax pool (ft)	6.15	8.19	10.72
Dmax run (ft)	5.26	6.33	7.36
Dmax glide (ft)	4.5	5.76	6.34
Low Bank Ht (ft)	3.36	3.72	4.06
Bankfull Slope (ft/ft)		0.00234	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.81	1.06	1.48
S pool / S bkf (ft/ft)	0.06	0.13	0.17
S run / S bkf (ft/ft)	0.45	3.01	5.36
S glide / S bkf (ft/ft)	0.21	0.57	0.82
P - P / W bkf (ft)	5.64	9.55	14.43
P length / W bkf (ft)	1.38	2.03	2.82
Dmax riffle / D bkf (ft)	1.16	1.52	1.69
Dmax pool / D bkf (ft)	2.00	2.67	3.49
Dmax run / D bkf (ft)	1.71	2.06	2.40
Dmax glide / D bkf (ft)	1.47	1.88	2.07
Low Bank Ht / Dmax riff (ft)	0.72	0.80	0.87
Bankfull Slope (ft/ft)		0.00234	

Channel Planform Dimensions and Dimensionless Ratios

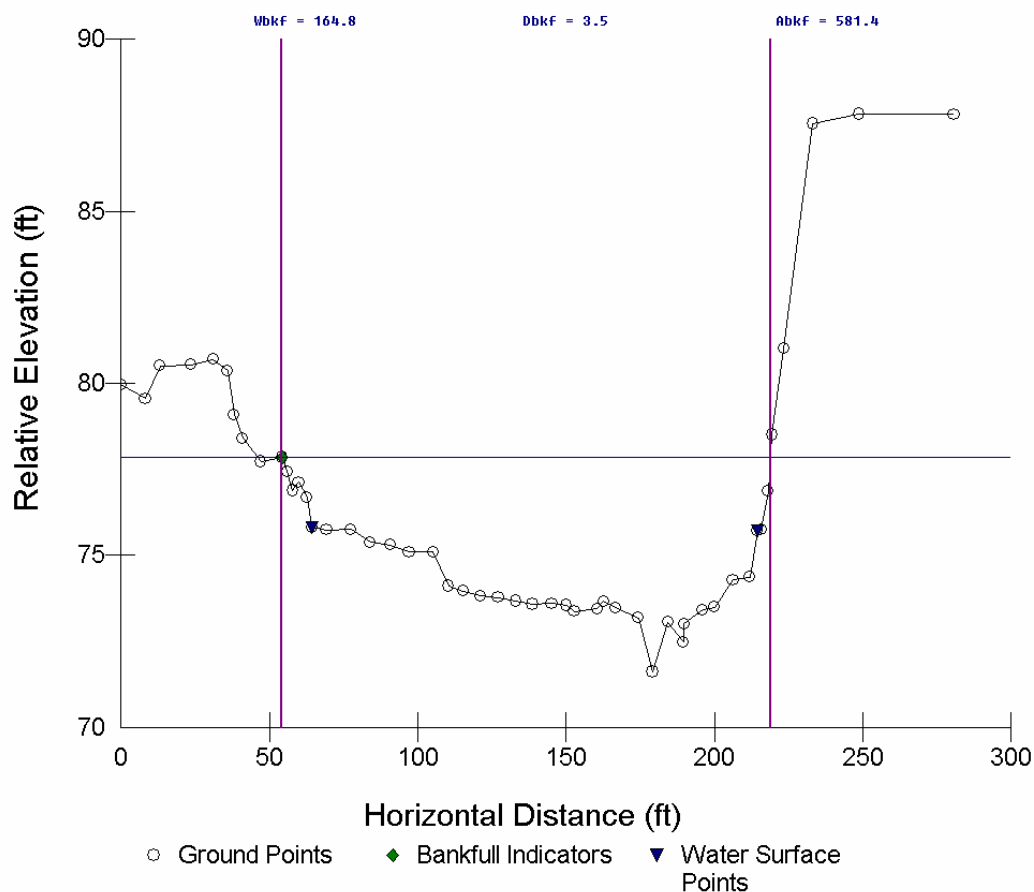
No Data

BFR near Ovando C Reach 2004



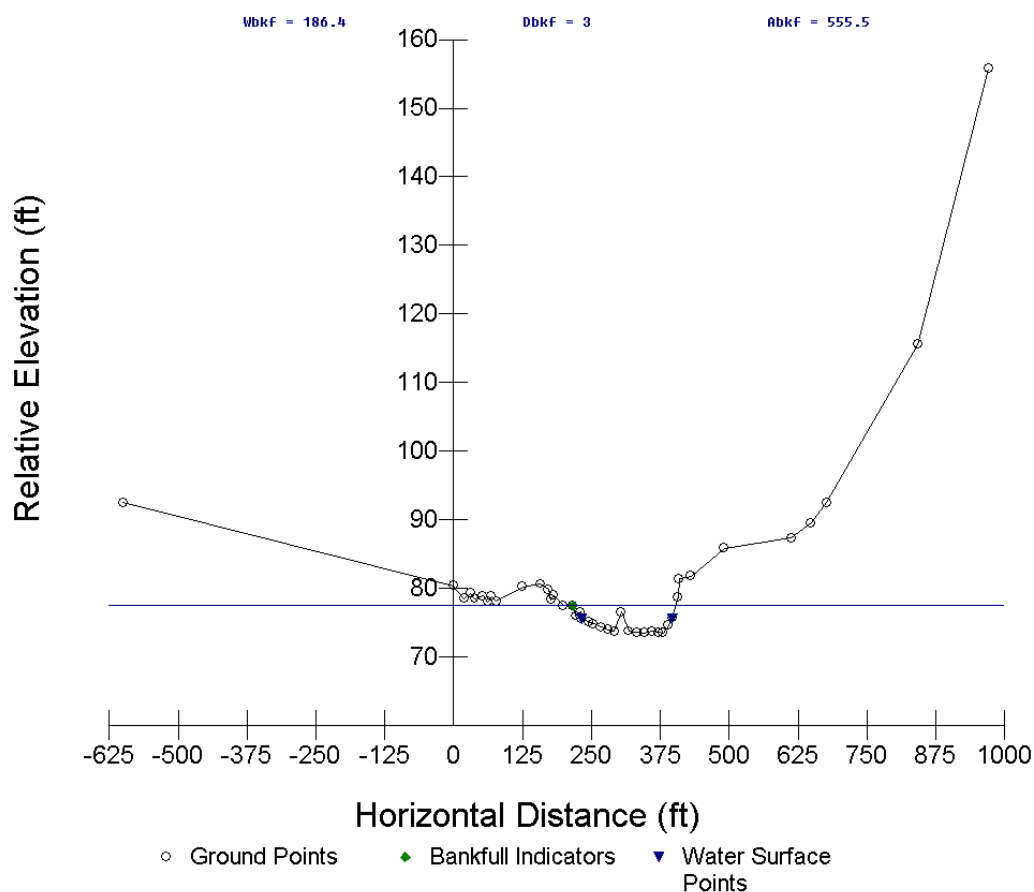
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00189	0.00247	0.00346
S pool (ft/ft)	0.00015	0.00031	0.00039
S run (ft/ft)	0.00106	0.00704	0.01254
S glide (ft/ft)	0.00049	0.00133	0.00193
P - P (ft)	911.54	1543.81	2332.46
P length (ft)	223.42	327.68	455.77
Dmax riffle (ft)	3.55	4.66	5.2
Dmax pool (ft)	6.15	8.19	10.72
Dmax run (ft)	5.26	6.33	7.36
Dmax glide (ft)	4.5	5.76	6.34
Low Bank Ht (ft)	3.36	3.72	4.06
Bankfull Slope (ft/ft)		0.00234	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.81	1.06	1.48
S pool / S bkf (ft/ft)	0.06	0.13	0.17
S run / S bkf (ft/ft)	0.45	3.01	5.36
S glide / S bkf (ft/ft)	0.21	0.57	0.82
P - P / W bkf (ft)	5.64	9.55	14.43
P length / W bkf (ft)	1.38	2.03	2.82
Dmax riffle / D bkf (ft)	1.16	1.52	1.69
Dmax pool / D bkf (ft)	2.00	2.67	3.49
Dmax run / D bkf (ft)	1.71	2.06	2.40
Dmax glide / D bkf (ft)	1.47	1.88	2.07
Low Bank Ht / Dmax riff (ft)	0.72	0.80	0.87
Bankfull Slope (ft/ft)		0.00234	

Reach: **BFR near Ovando (C)** Cross-Section: **1**Channel Unit: **Run**

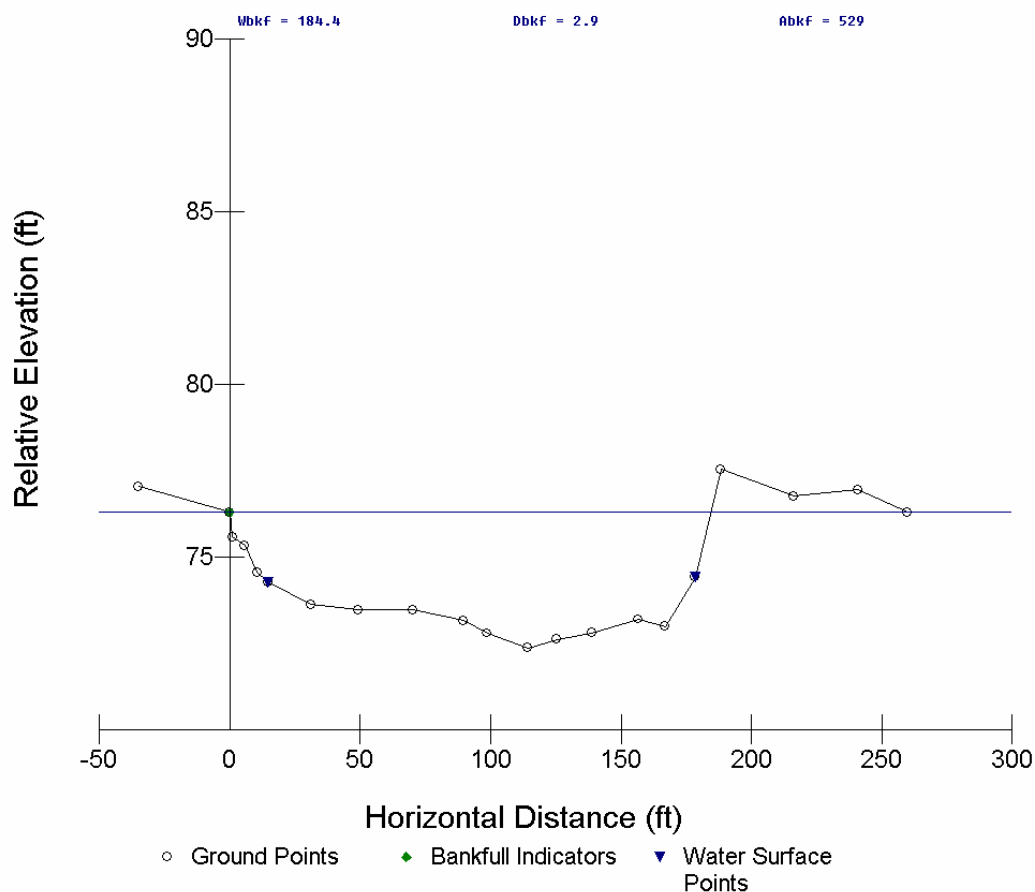
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 1 (Run)

	2004
Bankfull Area (ft ²)	581
Width/Depth Ratio	46.7
Bankfull Width (ft)	165
Mean Depth (ft)	3.5

Reach: **BFR near Ovando (C)** Cross-Section: **2**Channel Unit: **Glide**

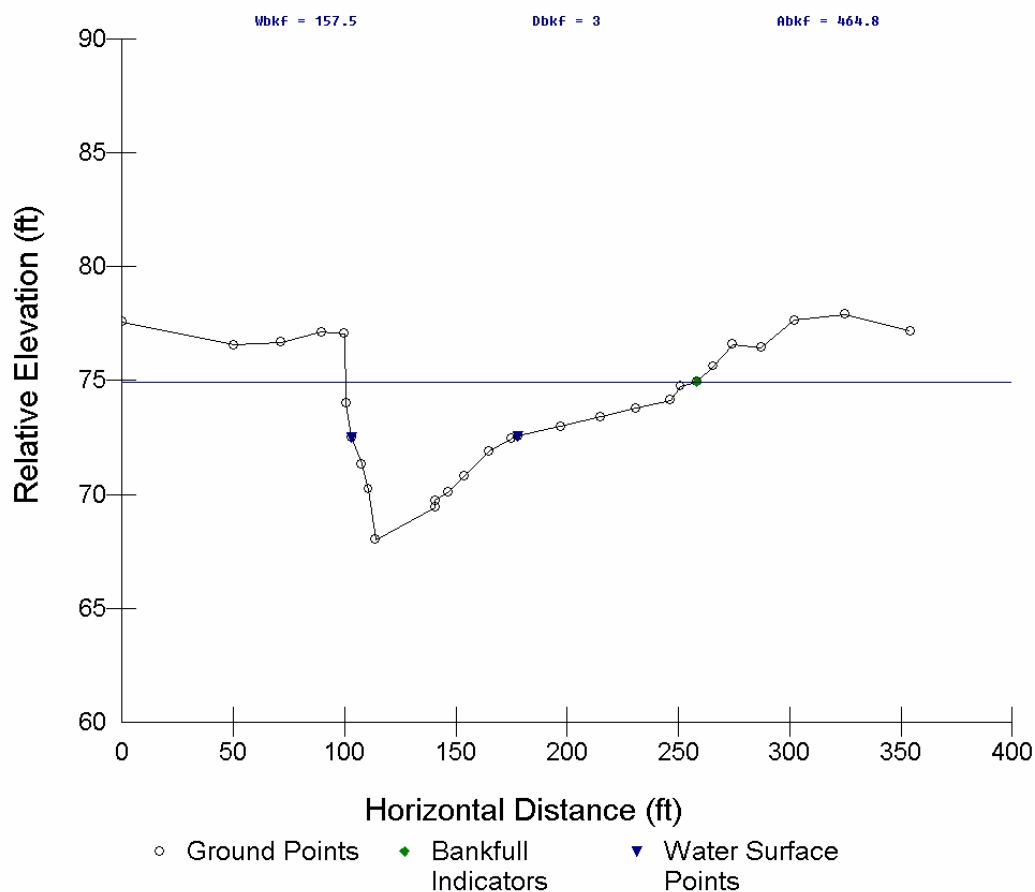
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 2 (Glide)

	2004
Bankfull Area (ft ²)	556
Width/Depth Ratio	62.5
Bankfull Width (ft)	186
Mean Depth (ft)	3.0

Reach: **BFR near Ovando (C)** Cross-Section: **3**Channel Unit: **Riffle**

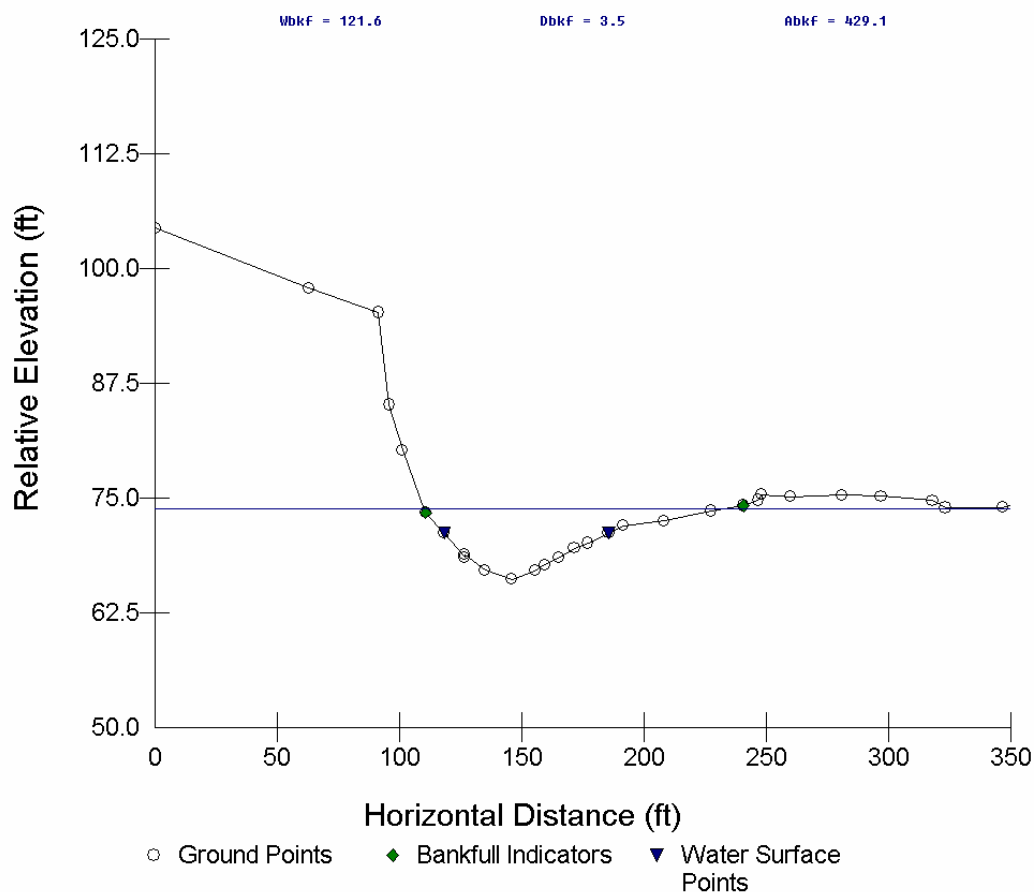
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 3 (Riffle)

	2004
Bankfull Area (ft ²)	529
Width/Depth Ratio	64.3
Bankfull Width (ft)	184
Mean Depth (ft)	2.9

Reach: **BFR near Ovando (C)** Cross-Section: **4**Channel Unit: **Run**

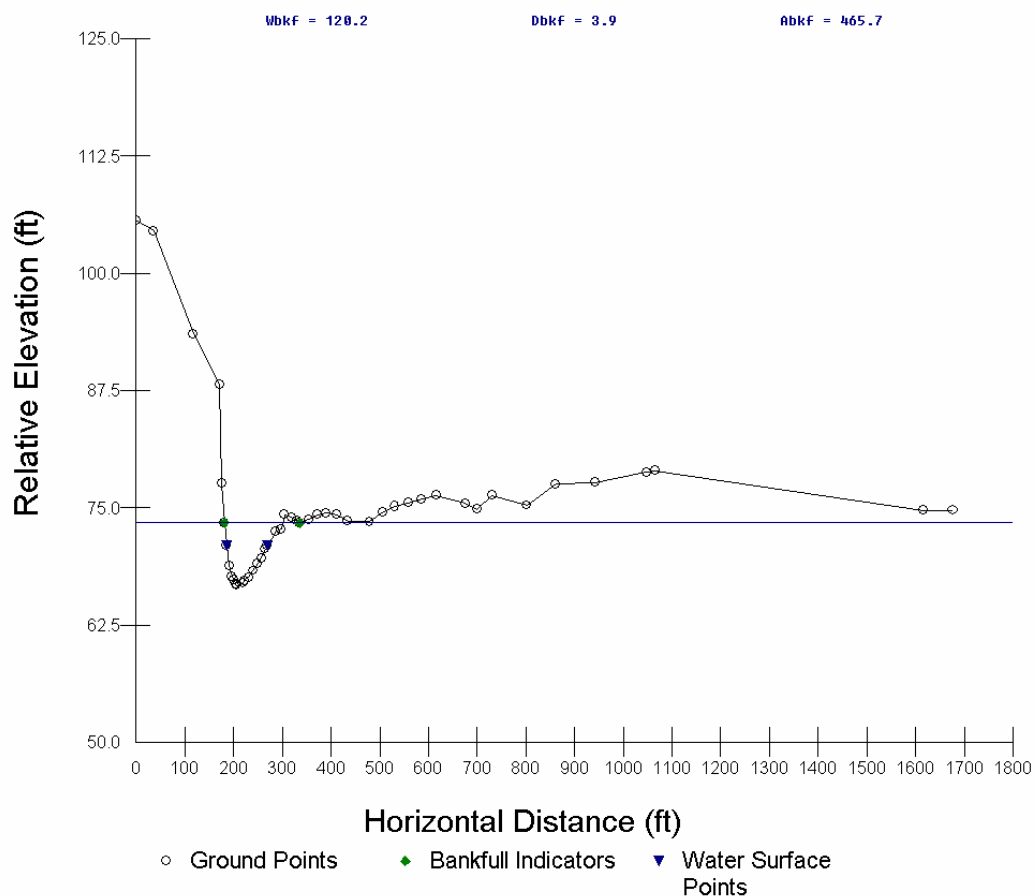
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 4 (Run)

	2004
Bankfull Area (ft ²)	465
Width/Depth Ratio	53.4
Bankfull Width (ft)	157
Mean Depth (ft)	3.0

Reach: **BFR near Ovando (C)** Cross-Section: **5**Channel Unit: **Pool**

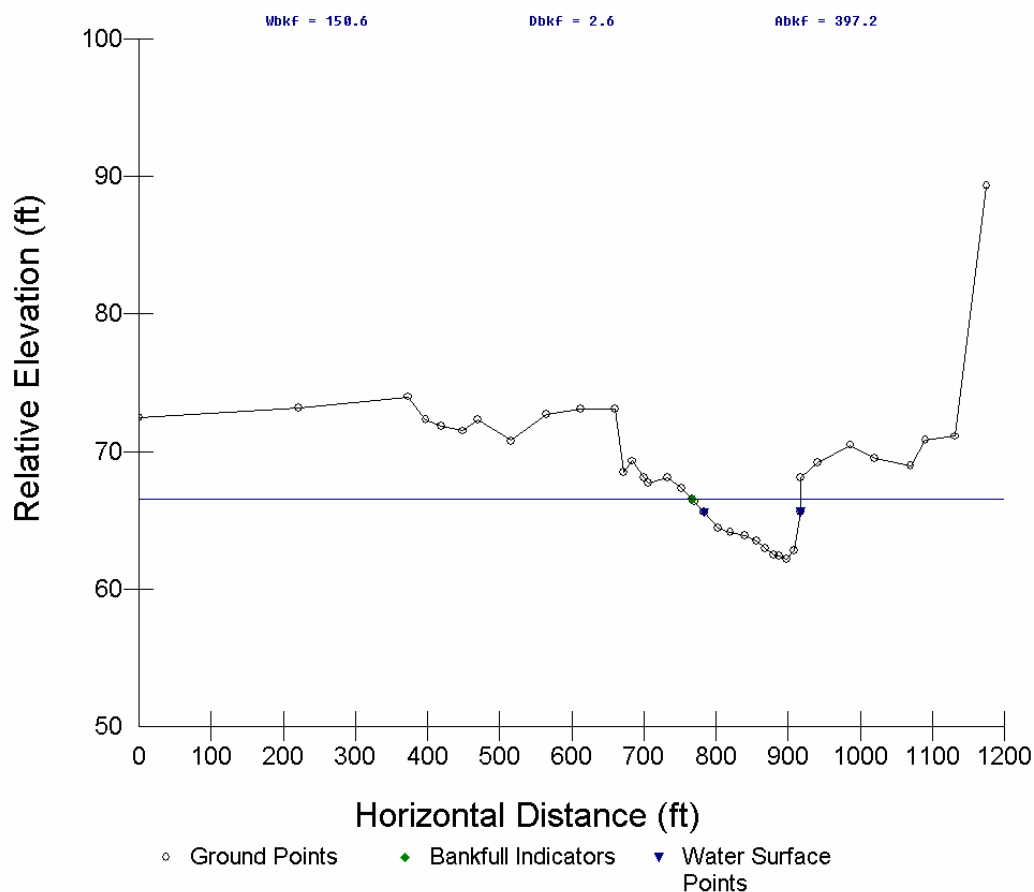
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 5 (Pool)

	2004
Bankfull Area (ft ²)	429
Width/Depth Ratio	34.5
Bankfull Width (ft)	122
Mean Depth (ft)	3.5

Reach: **BFR near Ovando (C)** Cross-Section: **6**Channel Unit: **Glide**

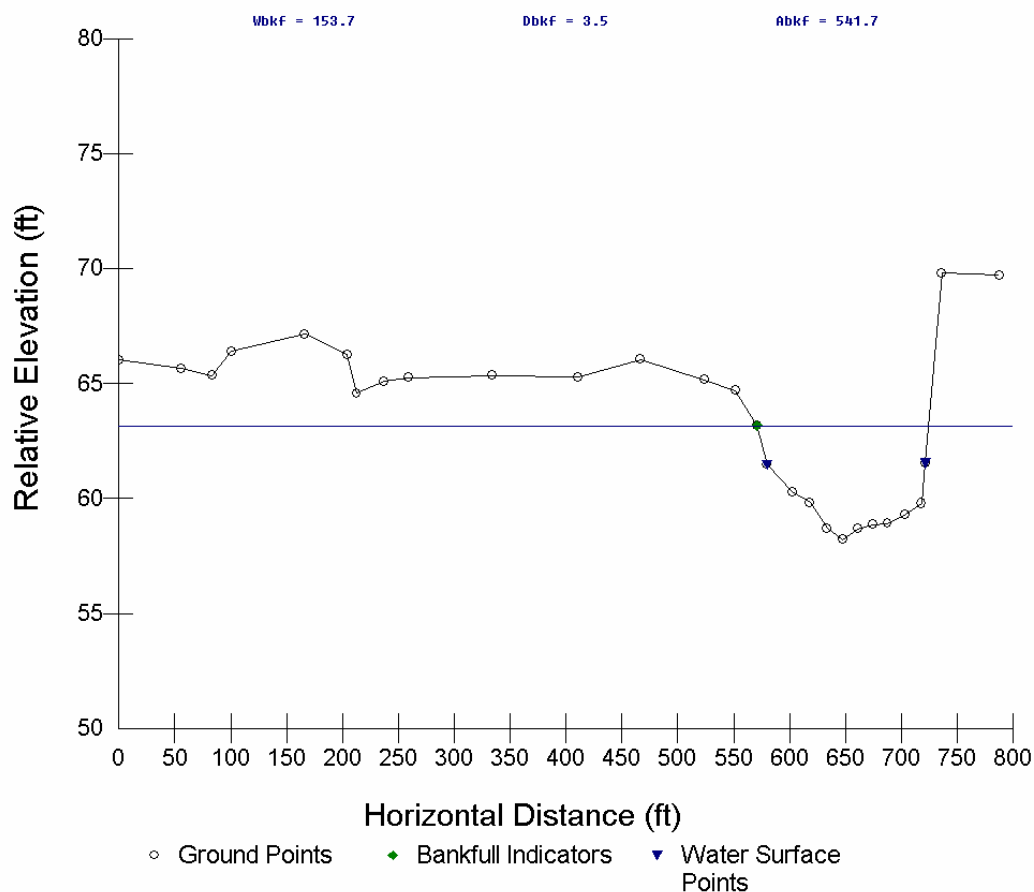
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 6 (Glide)

	2004
Bankfull Area (ft ²)	466
Width/Depth Ratio	31.0
Bankfull Width (ft)	120
Mean Depth (ft)	3.9

Reach: **BFR near Ovando (C)** Cross-Section: **7**Channel Unit: **Run**

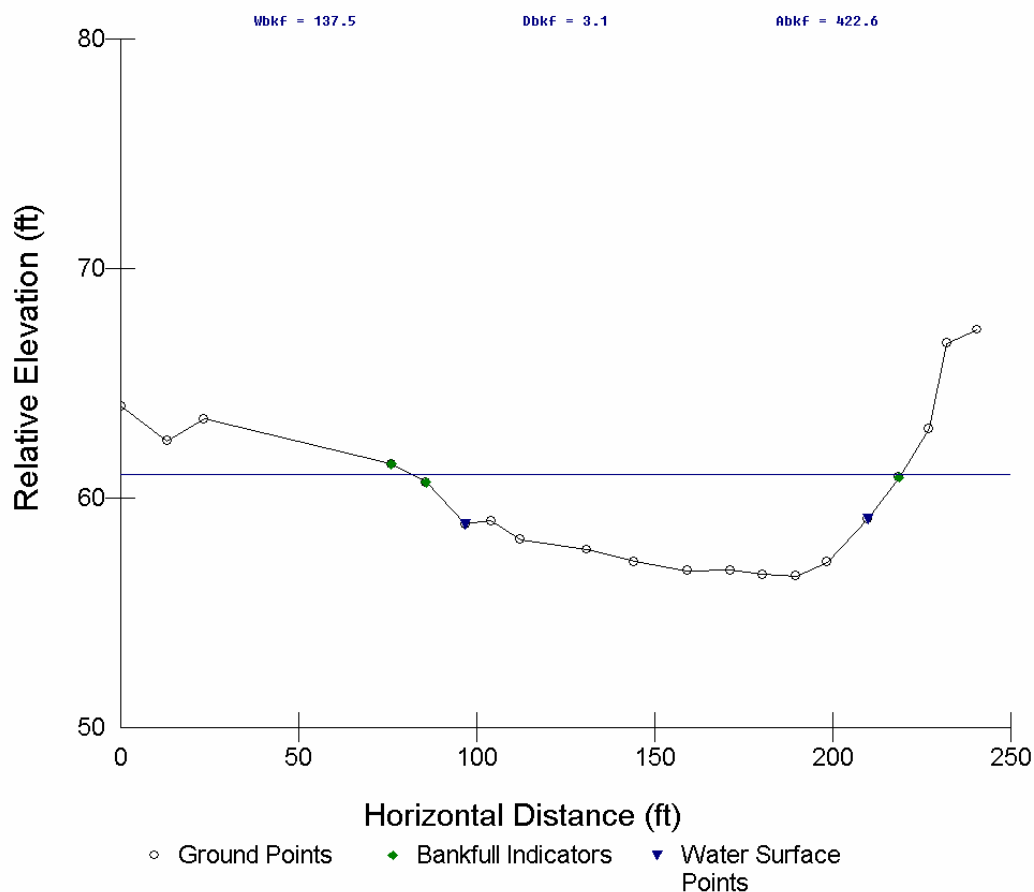
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 7 (Run)

	2004
Bankfull Area (ft ²)	397
Width/Depth Ratio	57.0
Bankfull Width (ft)	151
Mean Depth (ft)	2.6

Reach: **BFR near Ovando (C)** Cross-Section: **8**Channel Unit: **Riffle**

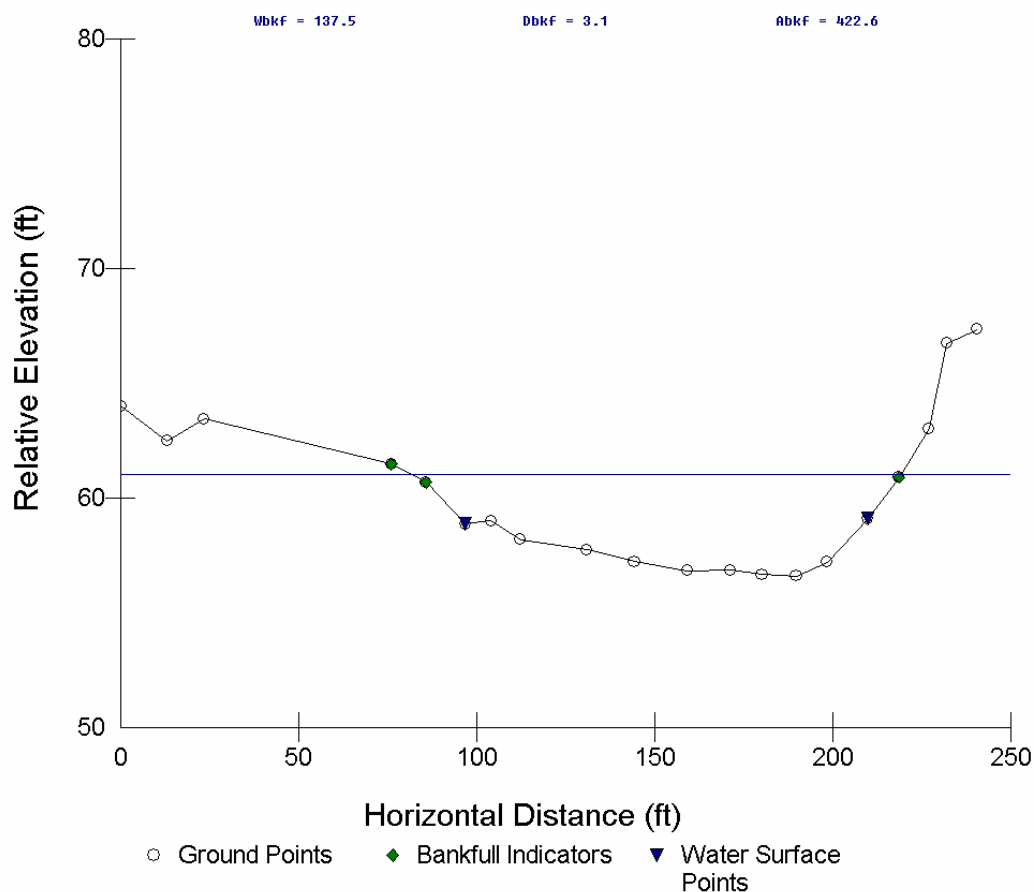
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 8 (Riffle)

	2004
Bankfull Area (ft ²)	542
Width/Depth Ratio	43.7
Bankfull Width (ft)	154
Mean Depth (ft)	3.5

Reach: **BFR near Ovando (C)** Cross-Section: **9**Channel Unit: **Riffle**

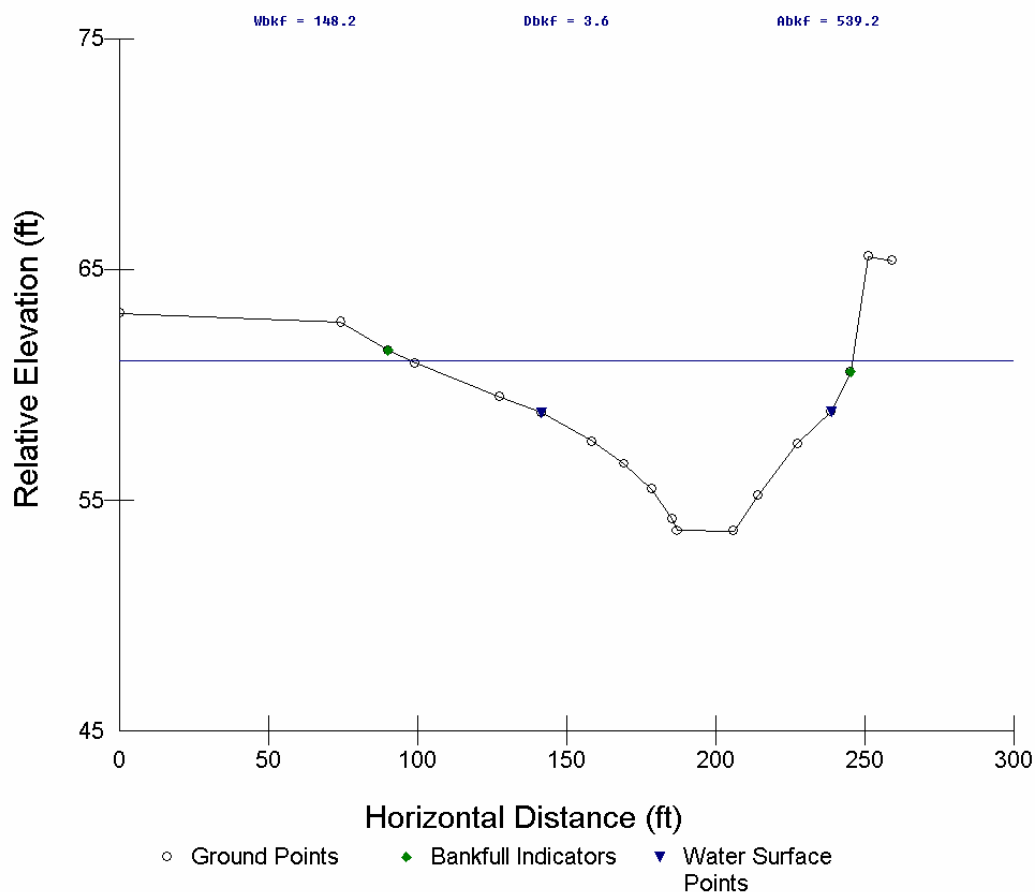
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 9 (Riffle)

	2004
Bankfull Area (ft ²)	425
Width/Depth Ratio	64.8
Bankfull Width (ft)	166
Mean Depth (ft)	2.6

Reach: **BFR near Ovando (C)** Cross-Section: **10**Channel Unit: **Riffle**

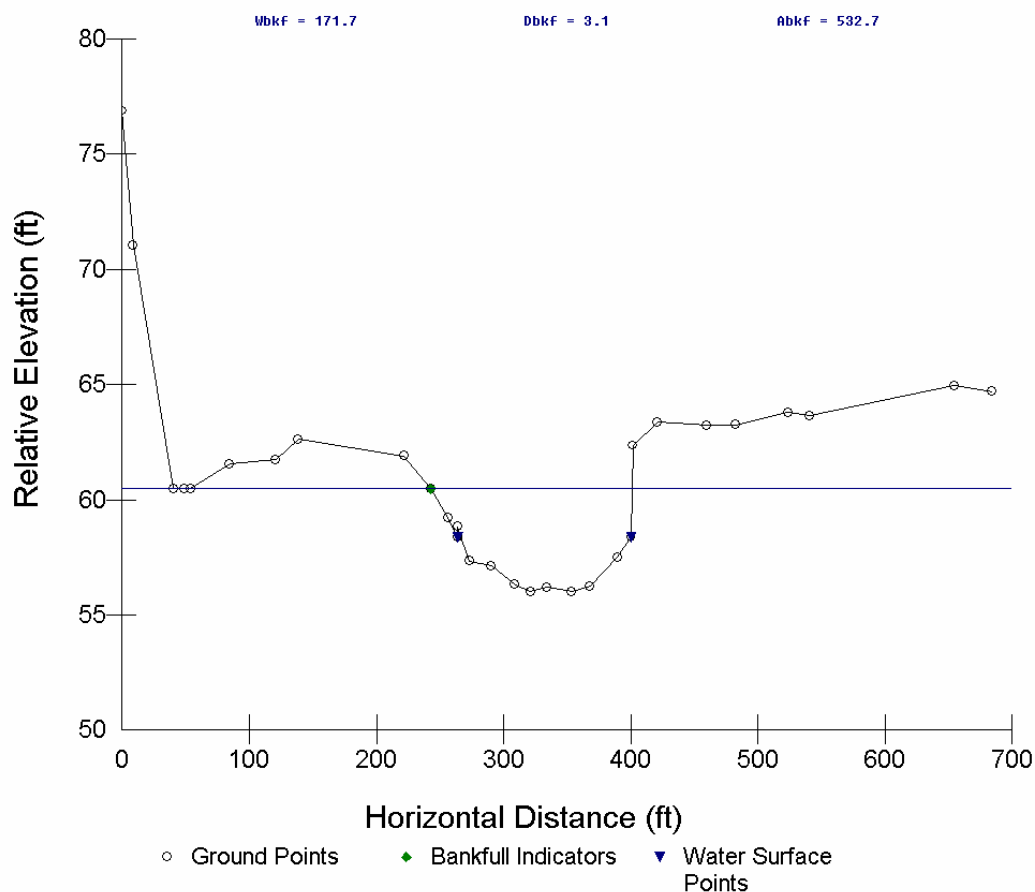
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 10 (Riffle)

	2004
Bankfull Area (ft ²)	423
Width/Depth Ratio	44.8
Bankfull Width (ft)	137
Mean Depth (ft)	3.1

Reach: **BFR near Ovando (C)** Cross-Section: **11**Channel Unit: **Pool**

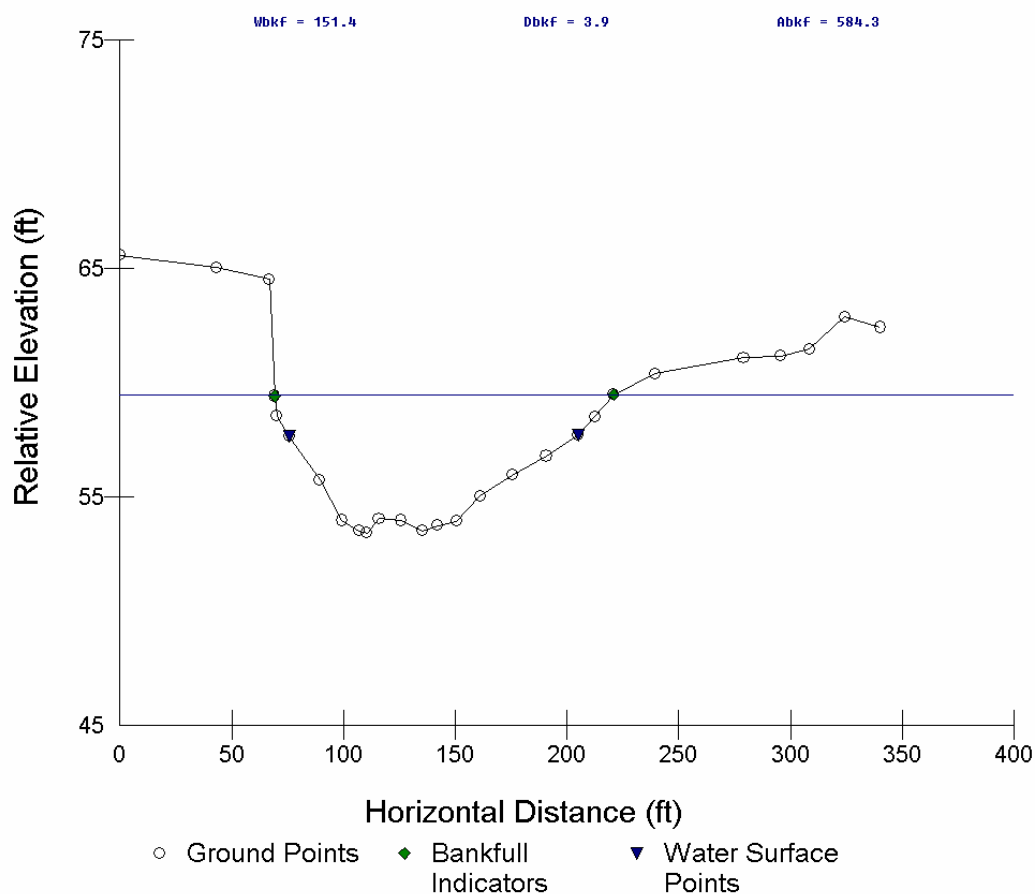
Channel Cross-Section Summary Data
 BFR near Ovando, Cross-Section 11 (Pool)

	2004
Bankfull Area (ft ²)	539
Width/Depth Ratio	40.7
Bankfull Width (ft)	148
Mean Depth (ft)	3.6

Reach: **BFR near Ovando (C)** Cross-Section: **12**Channel Unit: **Glide**

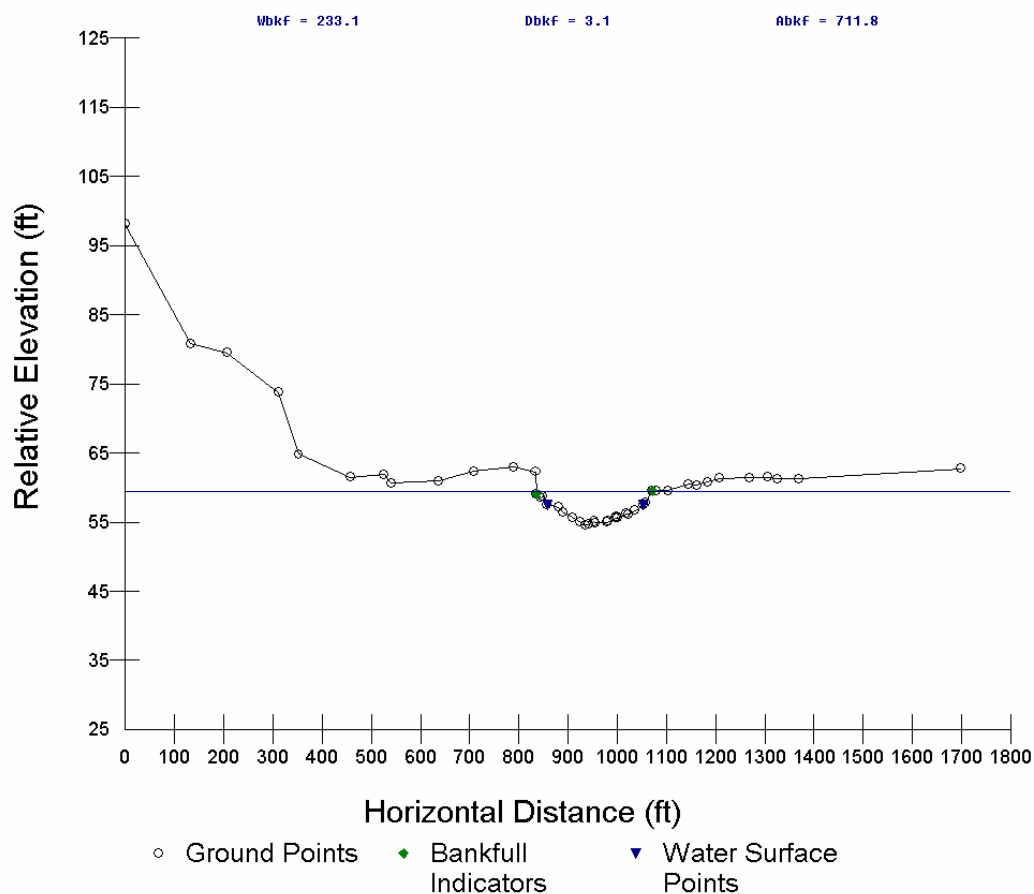
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 12 (Glide)

	2004
Bankfull Area (ft ²)	533
Width/Depth Ratio	55.4
Bankfull Width (ft)	172
Mean Depth (ft)	3.1

Reach: **BFR near Ovando (C)** Cross-Section: **14**Channel Unit: **Pool**

Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 14 (Pool)

	2004
Bankfull Area (ft ²)	584
Width/Depth Ratio	39.2
Bankfull Width (ft)	151
Mean Depth (ft)	3.9

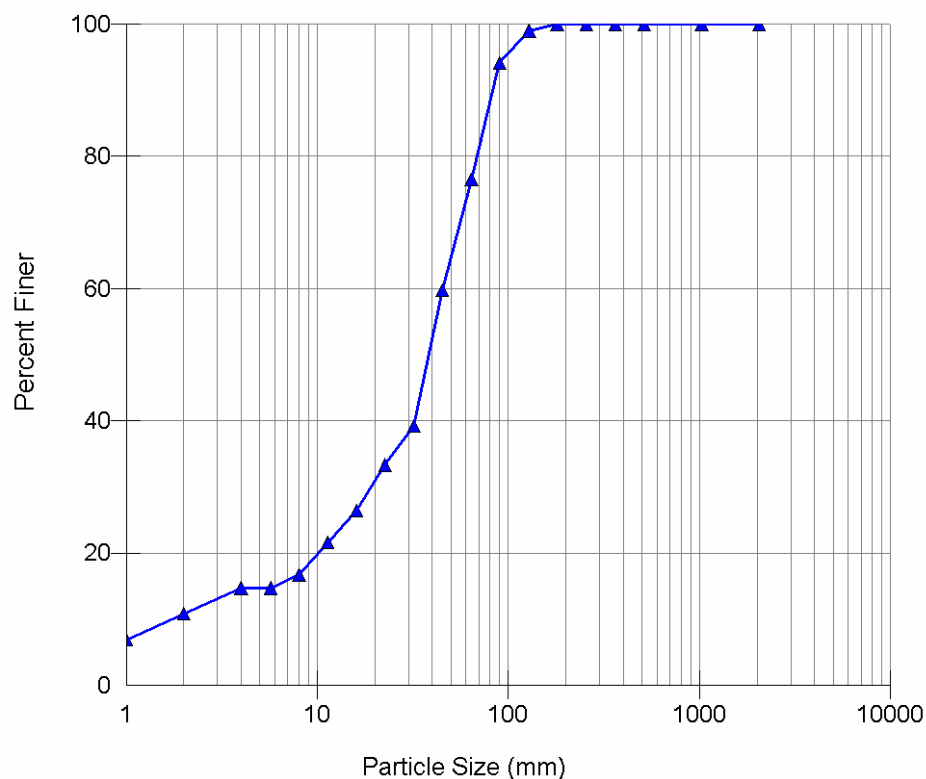
Reach: **BFR near Ovando (C)** Cross-Section: **15**Channel Unit: **Glide**

Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 15 (Glide)

	2004
Bankfull Area (ft ²)	712
Width/Depth Ratio	76.4
Bankfull Width (ft)	233
Mean Depth (ft)	3.1

Reach: **BFR near Ovando (C)** Cross-Sections: **3** Channel Unit: **Riffle**

Wolman Pebble Count



Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 3 (Riffle)

Size Class	XS 3 Riffle
D16	7
D35	25
D50	39
D84	75
D95	97
D100	180

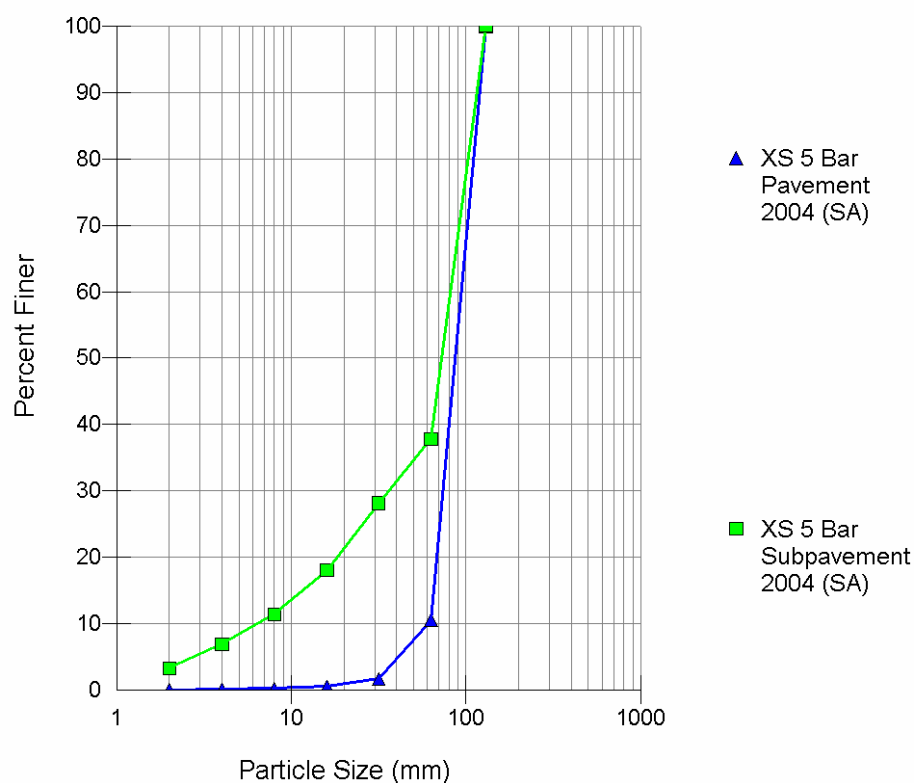
Riffle Stability Index (RSI) Results (mm)
BFR near Ovando, Point Bar at XS 5

2004		
Max ¹	Mean ²	RSI Score ³
265	200	D100

¹ Maximum particle size sampled from downstream one-third of point bar

² Geometric mean of the 30 largest sampled particles

³ Riffle size class corresponding to mean particle size measured from RSI

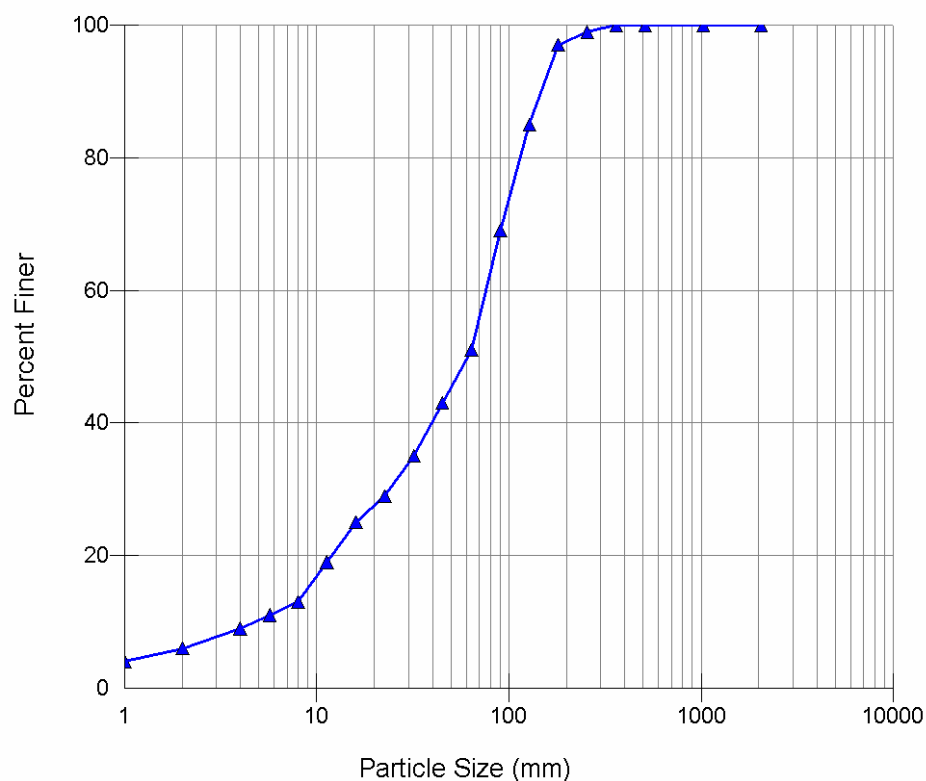
Reach: **BFR near Ovando (C)** Cross-Sections: **5**Channel Unit: **Pool/Bar****Substrate Pavement and Subpavement**

Substrate Pavement and Subpavement (mm)
BFR near Ovando, Cross-Section 5 (Pool/Bar)

Size Class	2004 Pavement	2004 Subpavement
D16	67	14
D35	81	54
D50	93	76
D84	118	113
D95	126	125
D100	135	135

Reach: **BFR near Ovando (C)** Cross-Section: **6 d/s** Channel Unit: **Riffle**

Wolman Pebble Count



Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 6 d/s (Riffle)

Size Class	XS 8 Riffle
D16	10
D35	32
D50	62
D84	126
D95	171
D100	362

Riffle Stability Index (RSI) Results (mm)
BFR near Ovando, Point Bar at XS 5

2004		
Max ¹	Mean ²	RSI Score ³
265	200	D97

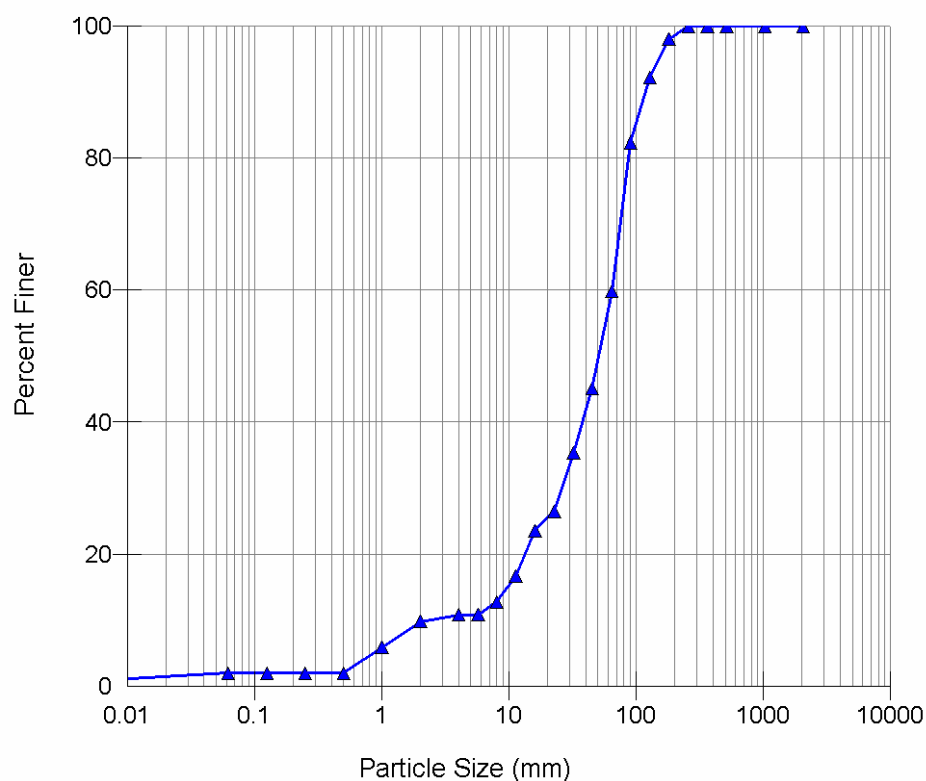
¹ Maximum particle size sampled from downstream one-third of point bar

² Geometric mean of the 30 largest sampled particles

³ Riffle size class corresponding to mean particle size measured from RSI

Reach: **BFR near Ovando (C)** Cross-Section: **7 d/s** Channel Unit: **Riffle**

Wolman Pebble Count



Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 7 d/s (Riffle)

Size Class	XS 9 Riffle
D16	11
D35	32
D50	51
D84	96
D95	153
D100	256

Riffle Stability Index (RSI) Results (mm)
BFR near Ovando, Point Bar at XS 13 and 14

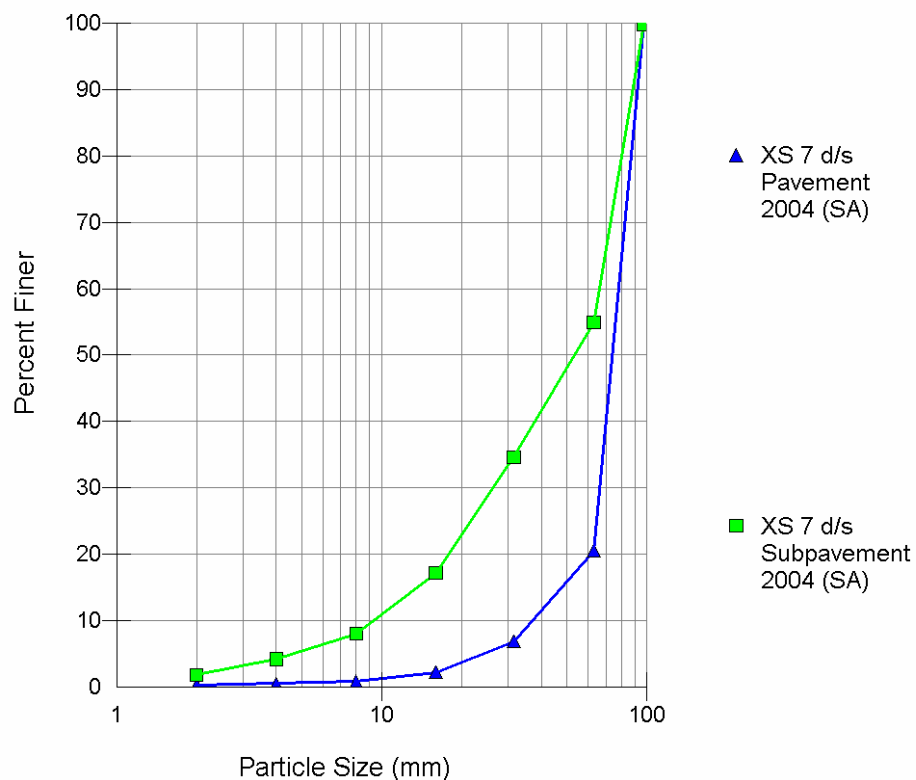
2004		
Max ¹	Mean ²	RSI Score ³
200	145	D93

¹ Maximum particle size sampled from downstream one-third of point bar

² Geometric mean of the 30 largest sampled particles

³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement

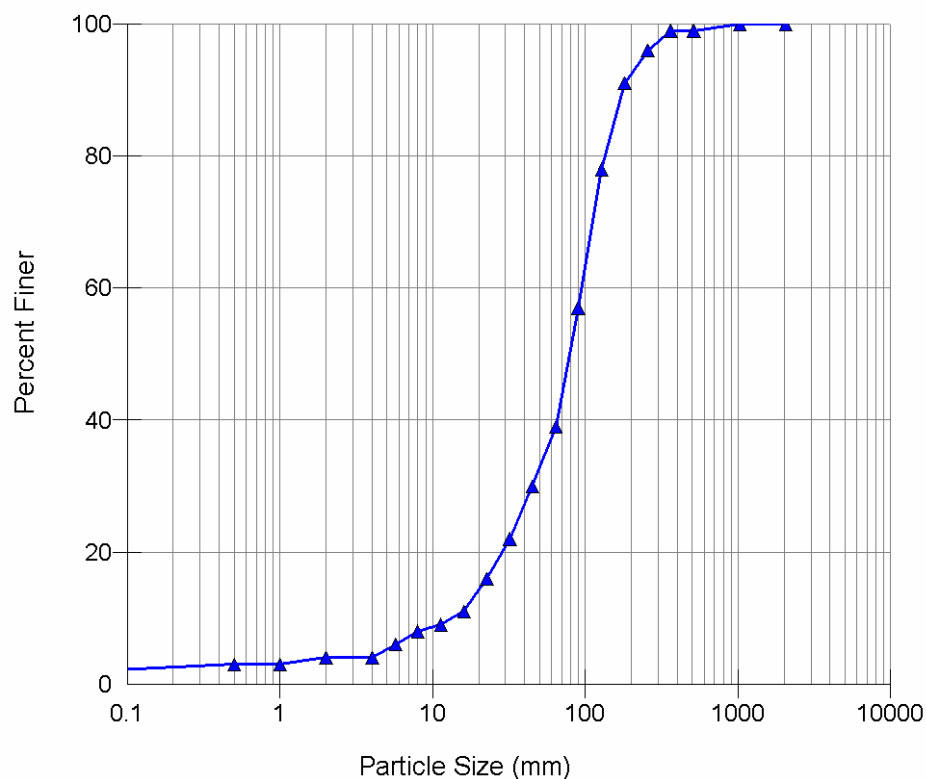


Substrate Pavement and Subpavement (mm)
BFR near Ovando, Cross-Section 7 d/s (Riffle)

Size Class	2004 Pavement	2004 Subpavement
D16	53	15
D35	69	32
D50	76	55
D84	90	85
D95	95	93
D100	97	97

Reach: **BFR near Ovando (C)** Cross-Section: **12#1** Channel Unit: **Glide**

Wolman Pebble Count



Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 12#1 (Glide)

Size Class	XS 12 Glide
D16	23
D35	56
D50	80
D84	152
D95	241
D100	1024

Riffle Stability Index (RSI) Results (mm)
BFR near Ovando, Point Bar at XS 13 and 14

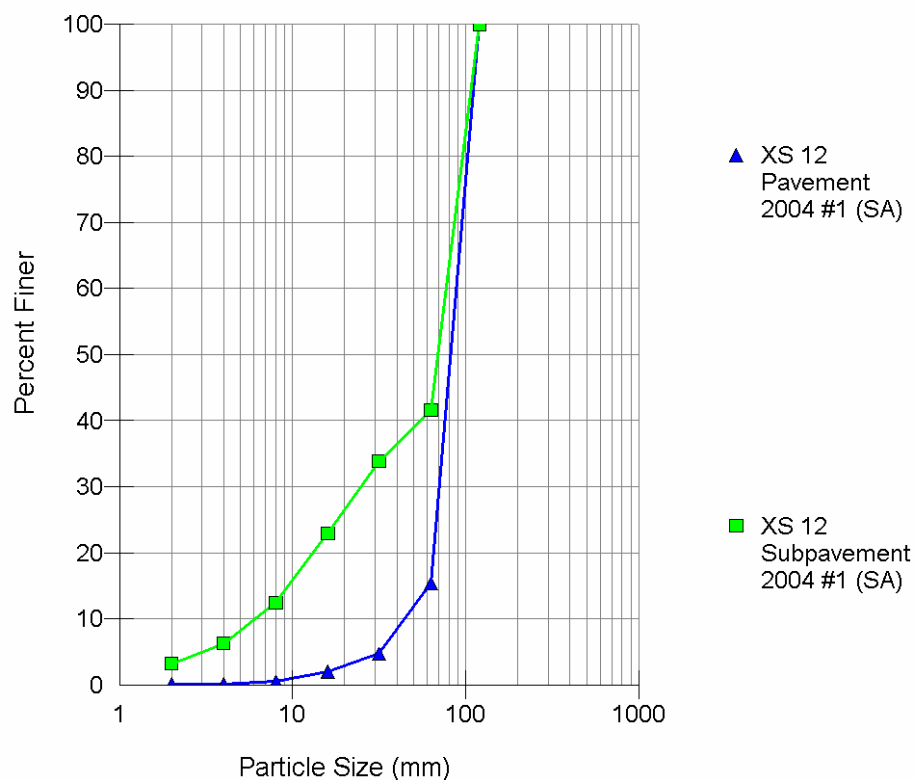
2004		
Max ¹	Mean ²	RSI Score ³
200	145	D81

¹ Maximum particle size sampled from downstream one-third of point bar

² Geometric mean of the 30 largest sampled particles

³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement

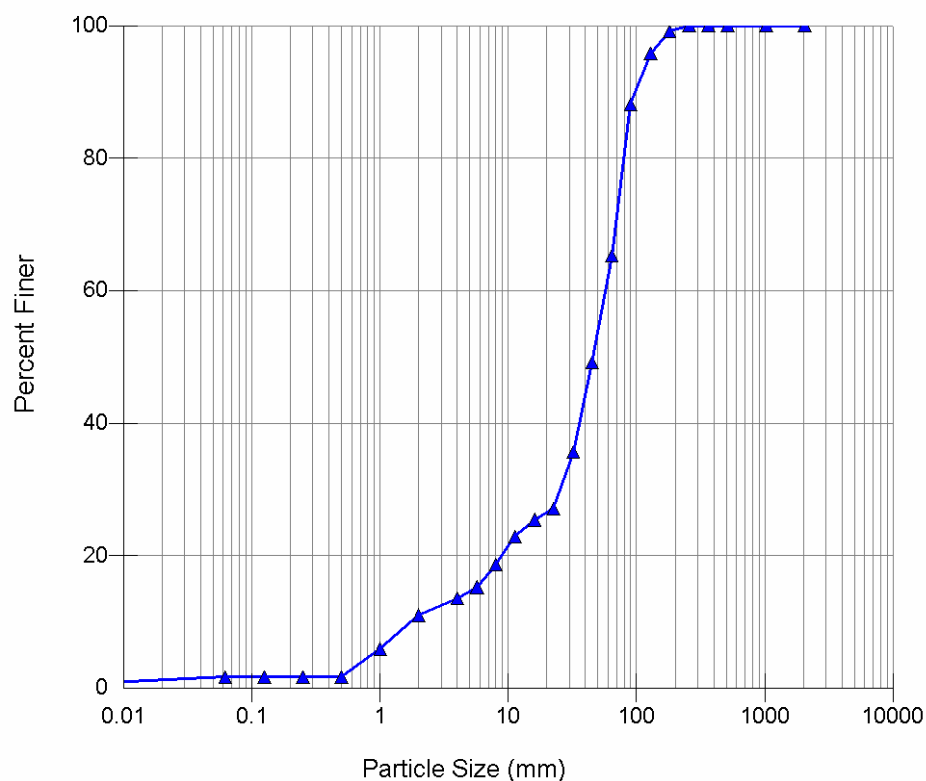


Substrate Pavement and Subpavement (mm)
BFR near Ovando, Cross-Section 12#1 (Glide)

Size Class	2004 Pavement	2004 Subpavement
D16	63	11
D35	76	36
D50	86	71
D84	109	104
D95	117	115
D100	120	120

Reach: **BFR near Ovando (C)** Cross-Section: **12#2** Channel Unit: **Glide**

Wolman Pebble Count



Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 12#2 (Glide)

Size Class	XS 12 Riffle
D16	6
D35	31
D50	46
D84	85
D95	124
D100	256

Riffle Stability Index (RSI) Results (mm)
BFR near Ovando, Point Bar at XS 13 and 14

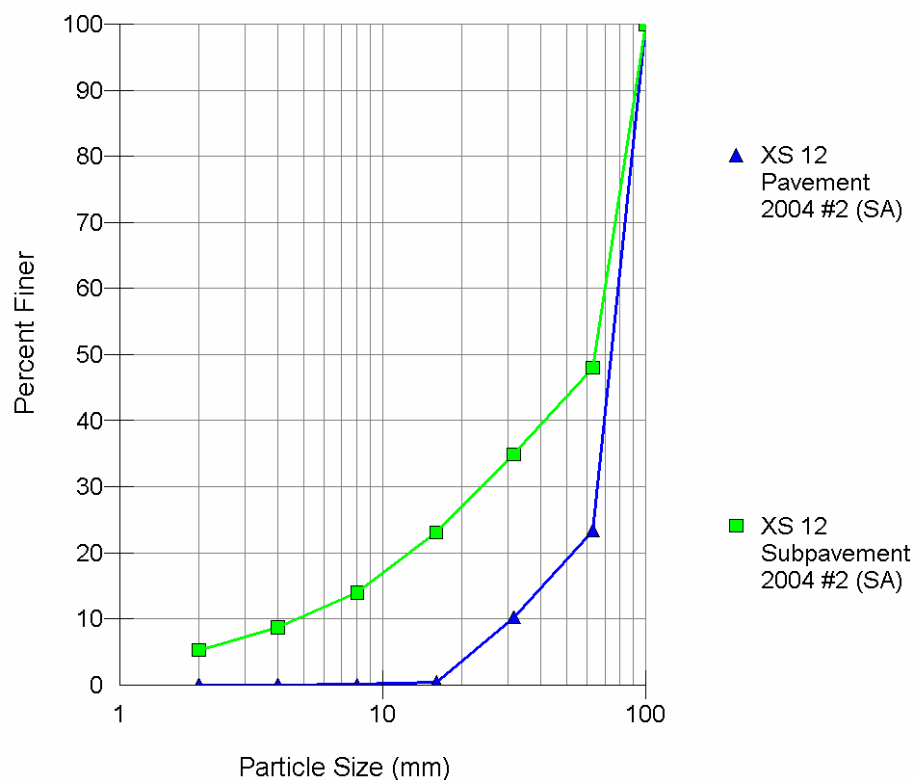
2004		
Max ¹	Mean ²	RSI Score ³
200	145	D96

¹ Maximum particle size sampled from downstream one-third of point bar

² Geometric mean of the 30 largest sampled particles

³ Riffle size class corresponding to mean particle size measured from RSI

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
BFR near Ovando, Cross-Section 12#2 (Glide)

Size Class	2004 Pavement	2004 Subpavement
D16	45	10
D35	69	32
D50	76	64
D84	92	89
D95	98	96
D100	100	100

Appendix J

BFR at Ovando B

REACH: BFR OVANDO B**Channel Cross-section Dimensions**

Reach	Cross-section Metric	Riffle 2004			Run 2004			Pool 2004	Glide 2004		
		Min	Mean	Max	Min	Mean	Max	Mean	Min	Mean	Max
BFR Ovando B	Bankfull Area (ft ²)	498.2	575.28	655.1	547.5	600.14	652.7	633.0	532.7	540	547.3
	Width/Depth Ratio	51.1	63.4	63.9	35.5	40.7	44.6	49.6	38.5	40.6	40.0
	Mean Depth (ft)	2.8	3.01	3.5	3.4	3.85	4.3	3.57	3.6	3.65	3.7
	Max Depth (ft)	3.8	4.73	5.6	4.3	5.29	6.3	7.93	5.2	5.83	6.4
	Width (ft)	178.3	190.89	217.1	152.3	156.51	160.8	177.2	143.1	148	153.0

Channel Cross-section Dimensionless Ratios**2004 Data**

Dimensionless Metric	Min	Mean	Max
Wfpa / Wbkf	1.10	1.31	1.46
Abkf	480.01	570.72	655.12
Dmbkf	3.77	4.73	5.63
Dbkf	2.79	3.13	3.49
Wbkf	146.47	182.93	217.10
Pool Area / Abkf	1.11	1.11	1.11
Max Pool Depth / Dbkf	2.53	2.53	2.53
Mean Pool Depth / Dbkf	1.14	1.14	1.14
Pool Width / Wbkf	0.97	0.97	0.97
Run Area / Abkf	0.96	1.05	1.14
Max Run Depth / Dbkf	1.36	1.69	2.02
Mean Run Depth / Dbkf	1.09	1.23	1.37
Run Width / Wbkf	0.83	0.86	0.88
Glide Area / Abkf	0.93	0.95	0.96
Max Glide Depth / Dbkf	1.67	1.86	2.05
Mean Glide Depth / Dbkf	1.14	1.17	1.19
Glide Width / Wbkf	0.78	0.81	0.84

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

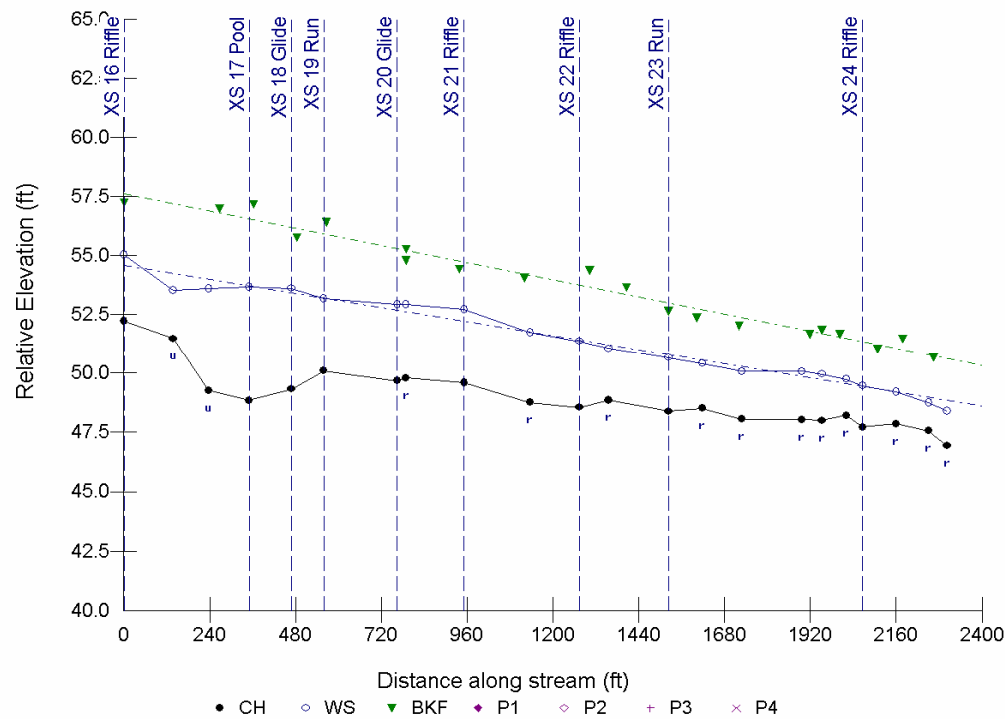
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00232	0.00382	0.00515
S pool (ft/ft)	0.00026	0.00026	0.00026
S run (ft/ft)	0.01075	0.01075	0.01075
S glide (ft/ft)	0.00366	0.00366	0.00366
P - P (ft)	0	0	0
P length (ft)	233.88	233.88	233.88
Dmax riffle (ft)	3.67	4.33	5.07
Dmax pool (ft)	7.69	7.69	7.69
Dmax run (ft)	6.84	6.84	6.84
Dmax glide (ft)	6.02	6.45	6.87
Low Bank Ht (ft)	3.20	3.20	3.20
Bankfull Slope (ft/ft)		0.00303	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.77	1.26	1.70
S pool / S bkf (ft/ft)	0.09	0.09	0.09
S run / S bkf (ft/ft)	3.55	3.55	3.55
S glide / S bkf (ft/ft)	1.21	1.21	1.21
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	1.28	1.28	1.28
Dmax riffle / D bkf (ft)	1.17	1.38	1.62
Dmax pool / D bkf (ft)	2.46	2.46	2.46
Dmax run / D bkf (ft)	2.19	2.19	2.19
Dmax glide / D bkf (ft)	1.92	2.06	2.19
Low Bank Ht / Dmax riff (ft)	0.74	0.74	0.74
Bankfull Slope (ft/ft)		0.00303	

Channel Planform Dimensions and Dimensionless Ratios

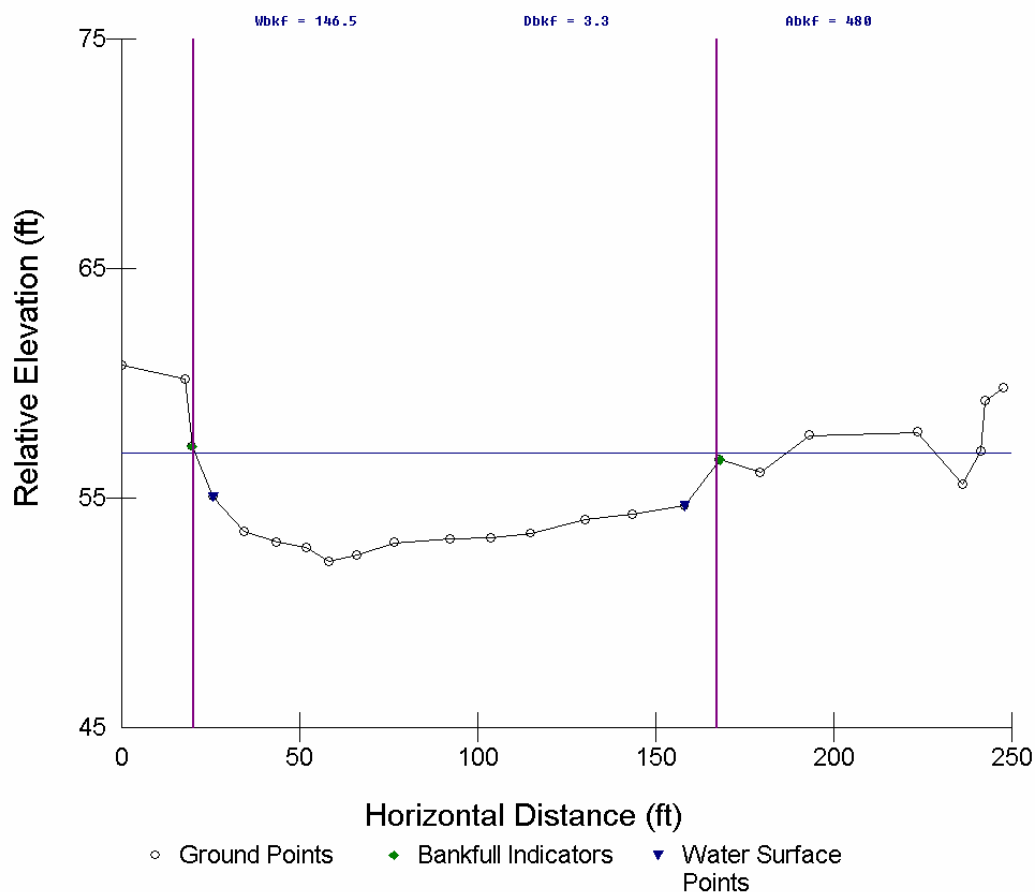
No Data

BFR near Ovando B Reach 2004



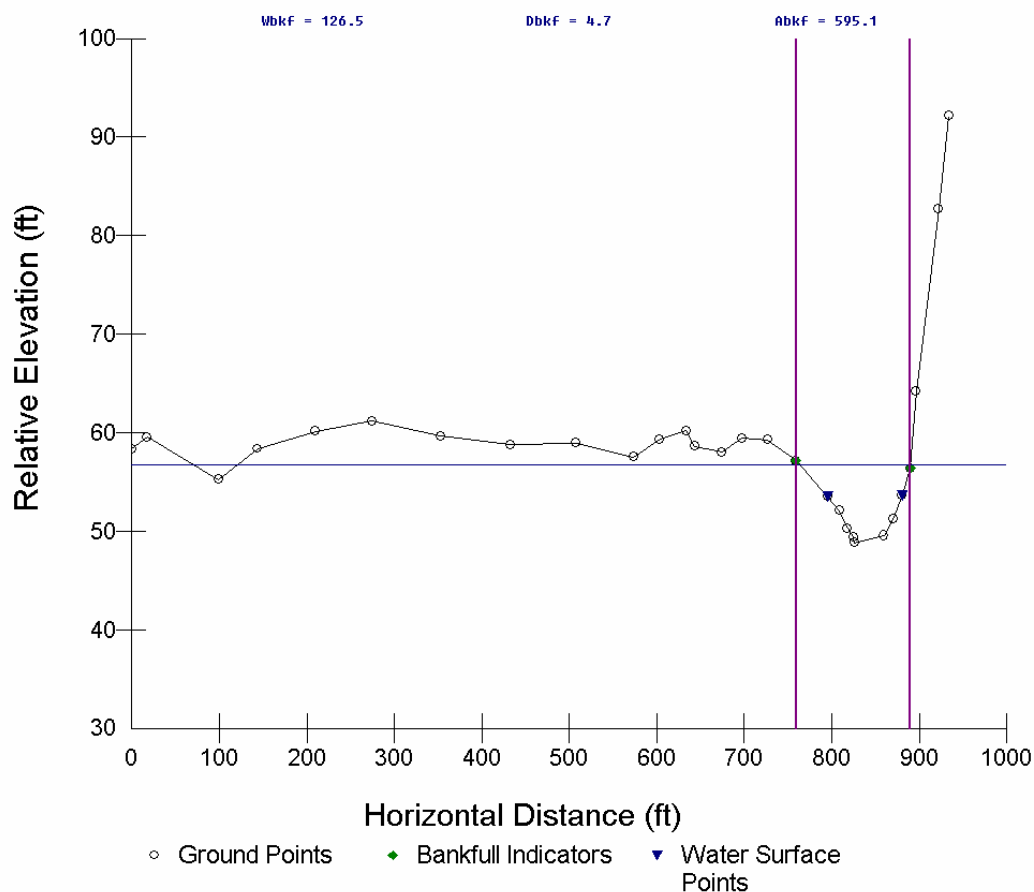
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00232	0.00382	0.00515
S pool (ft/ft)	0.00026	0.00026	0.00026
S run (ft/ft)	0.01075	0.01075	0.01075
S glide (ft/ft)	0.00366	0.00366	0.00366
P - P (ft)	0	0	0
P length (ft)	233.88	233.88	233.88
Dmax riffle (ft)	3.67	4.33	5.07
Dmax pool (ft)	7.69	7.69	7.69
Dmax run (ft)	6.84	6.84	6.84
Dmax glide (ft)	6.02	6.45	6.87
Low Bank Ht (ft)	3.20	3.20	3.20
Bankfull Slope (ft/ft)		0.00303	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.77	1.26	1.70
S pool / S bkf (ft/ft)	0.09	0.09	0.09
S run / S bkf (ft/ft)	3.55	3.55	3.55
S glide / S bkf (ft/ft)	1.21	1.21	1.21
P - P / W bkf (ft)	0.00	0.00	0.00
P length / W bkf (ft)	1.28	1.28	1.28
Dmax riffle / D bkf (ft)	1.17	1.38	1.62
Dmax pool / D bkf (ft)	2.46	2.46	2.46
Dmax run / D bkf (ft)	2.19	2.19	2.19
Dmax glide / D bkf (ft)	1.92	2.06	2.19
Low Bank Ht / Dmax riff (ft)	0.74	0.74	0.74
Bankfull Slope (ft/ft)		0.00303	

Reach: **BFR near Ovando (B)** Cross-Section: **16**Channel Unit: **Riffle**

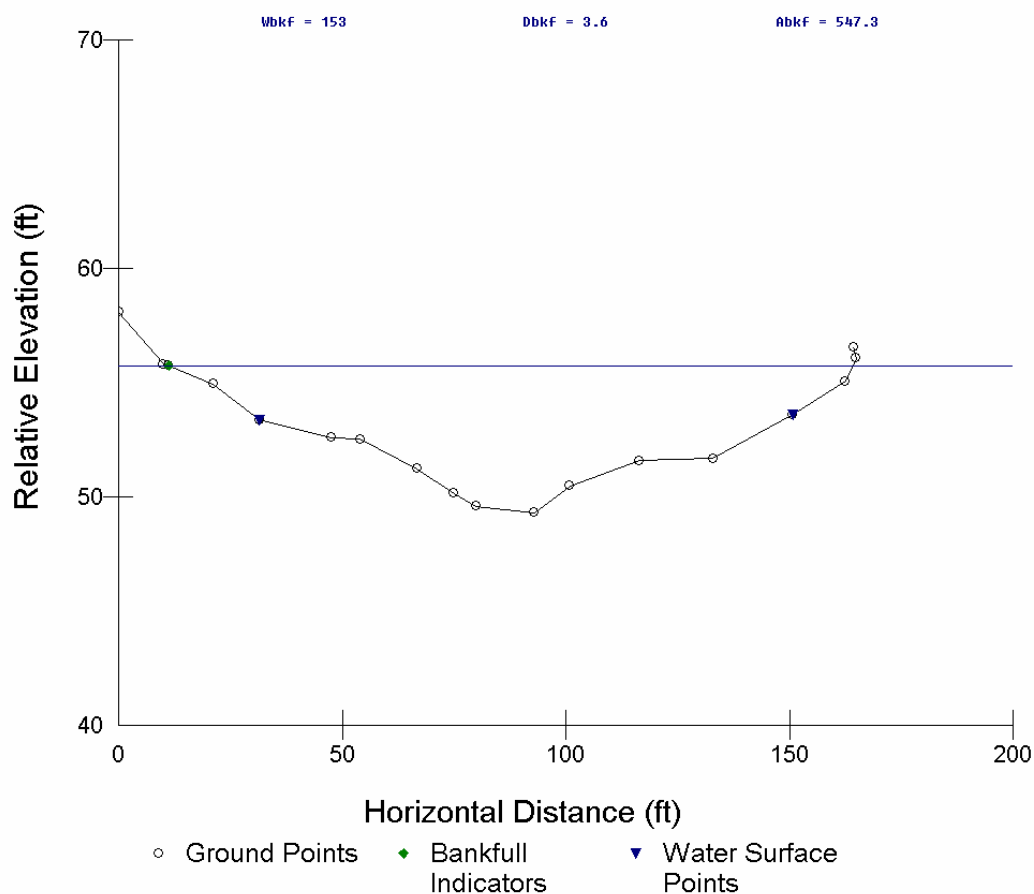
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 16 (Riffle)

	2004
Bankfull Area (ft ²)	480
Width/Depth Ratio	44.7
Bankfull Width (ft)	146
Mean Depth (ft)	3.3

Reach: **BFR near Ovando (B)** Cross-Section: **17**Channel Unit: **Pool**

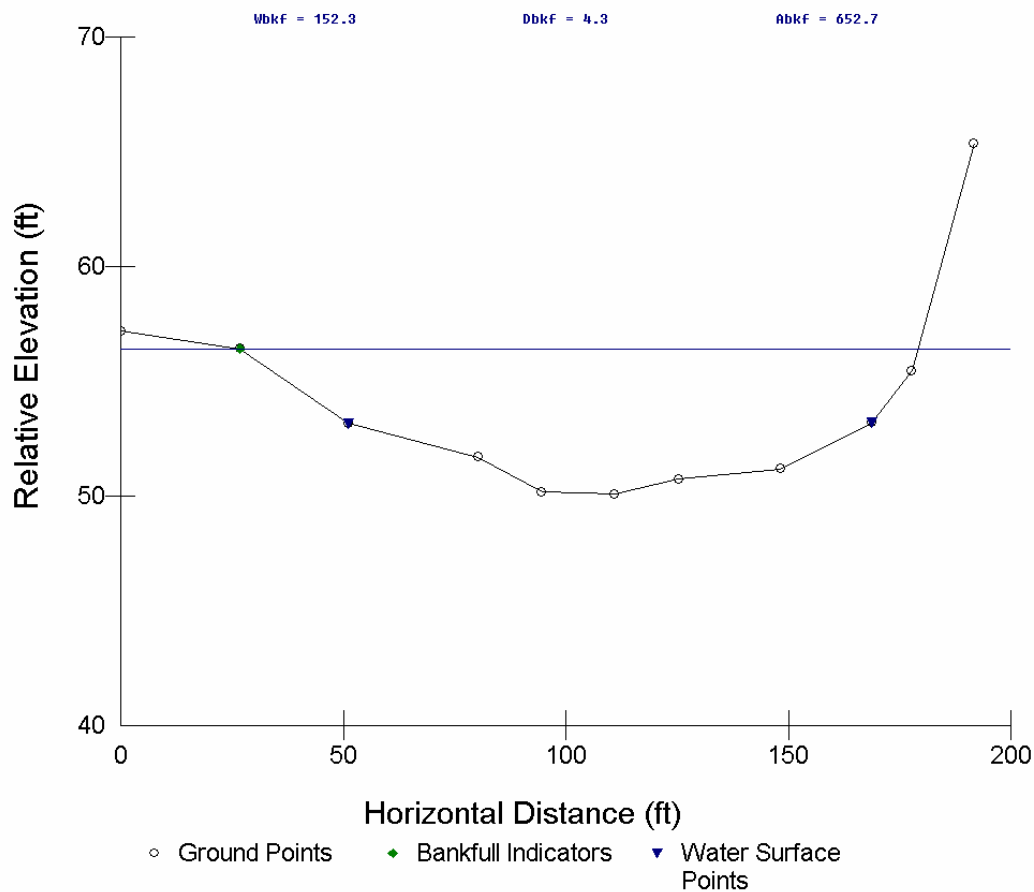
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 17 (Pool)

	2004
Bankfull Area (ft ²)	595
Width/Depth Ratio	26.9
Bankfull Width (ft)	127
Mean Depth (ft)	4.7

Reach: **BFR near Ovando (B)** Cross-Section: **18**Channel Unit: **Glide**

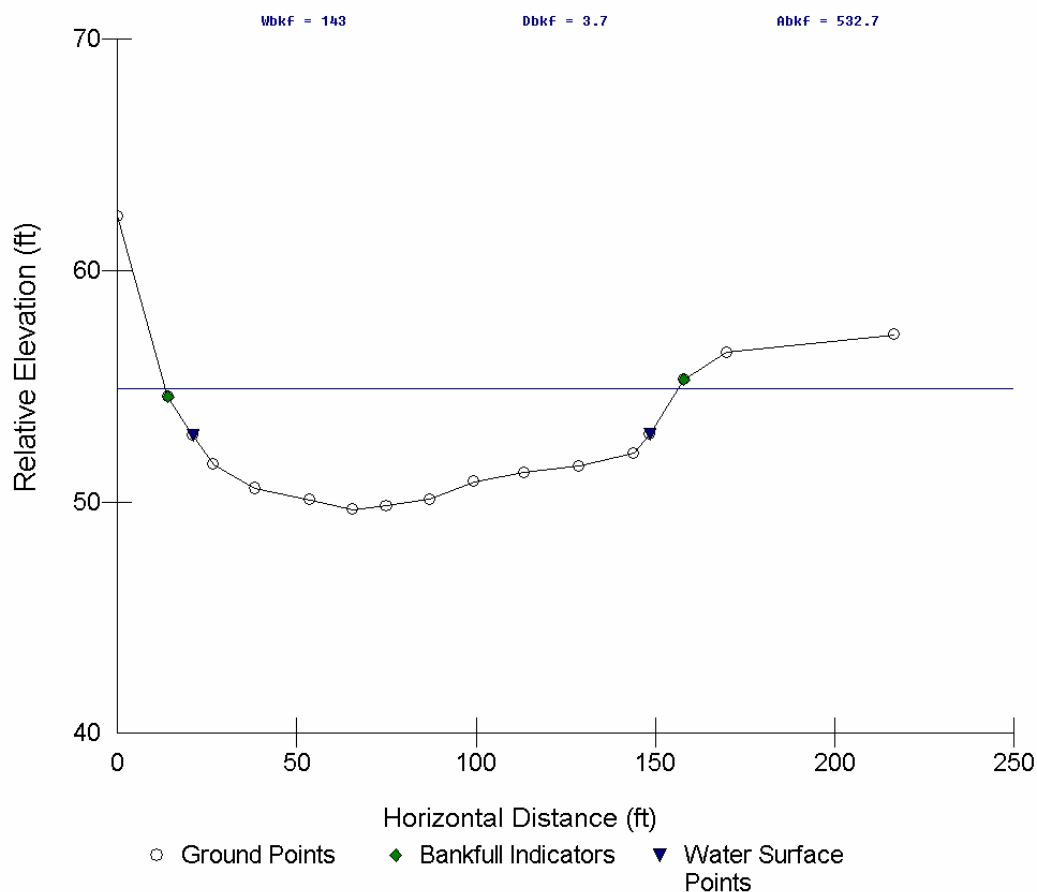
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 18 (Glide)

	2004
Bankfull Area (ft ²)	547
Width/Depth Ratio	42.7
Bankfull Width (ft)	153
Mean Depth (ft)	3.6

Reach: **BFR near Ovando (B)** Cross-Section: **19**Channel Unit: **Run**

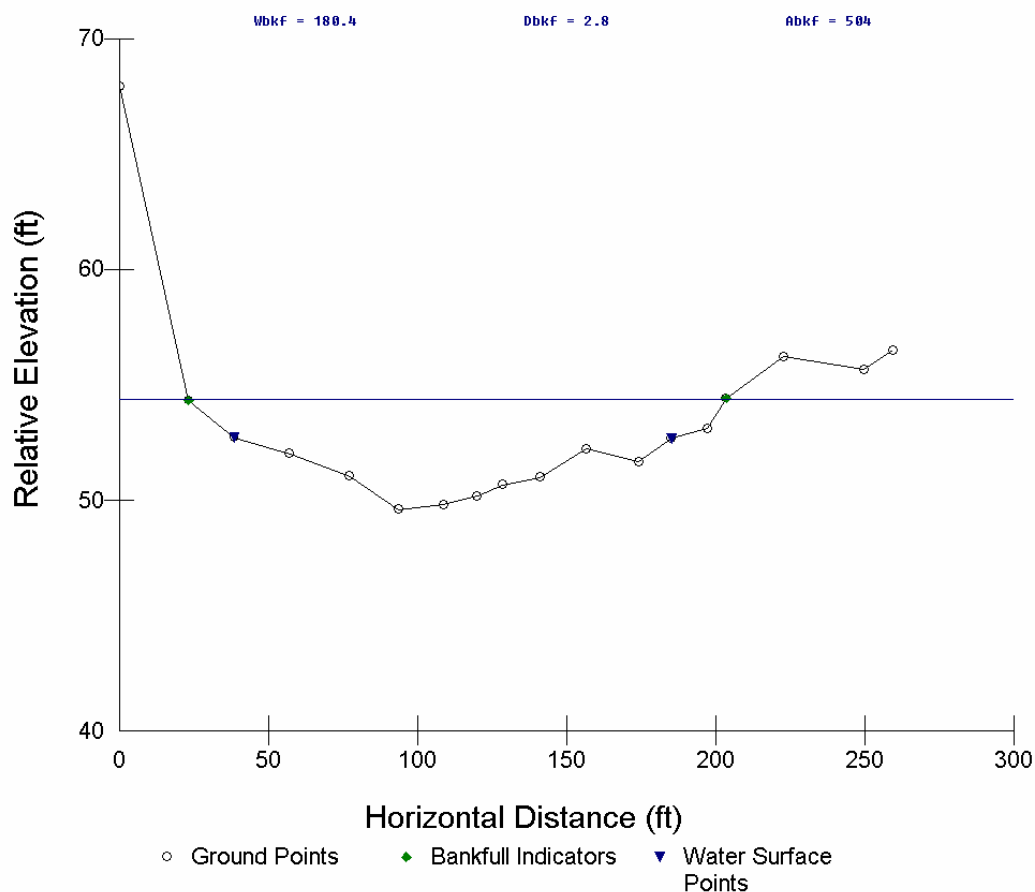
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 19 (Run)

	2004
Bankfull Area (ft ²)	653
Width/Depth Ratio	35.5
Bankfull Width (ft)	152
Mean Depth (ft)	4.3

Reach: **BFR near Ovando (B)** Cross-Section: **20**Channel Unit: **Glide**

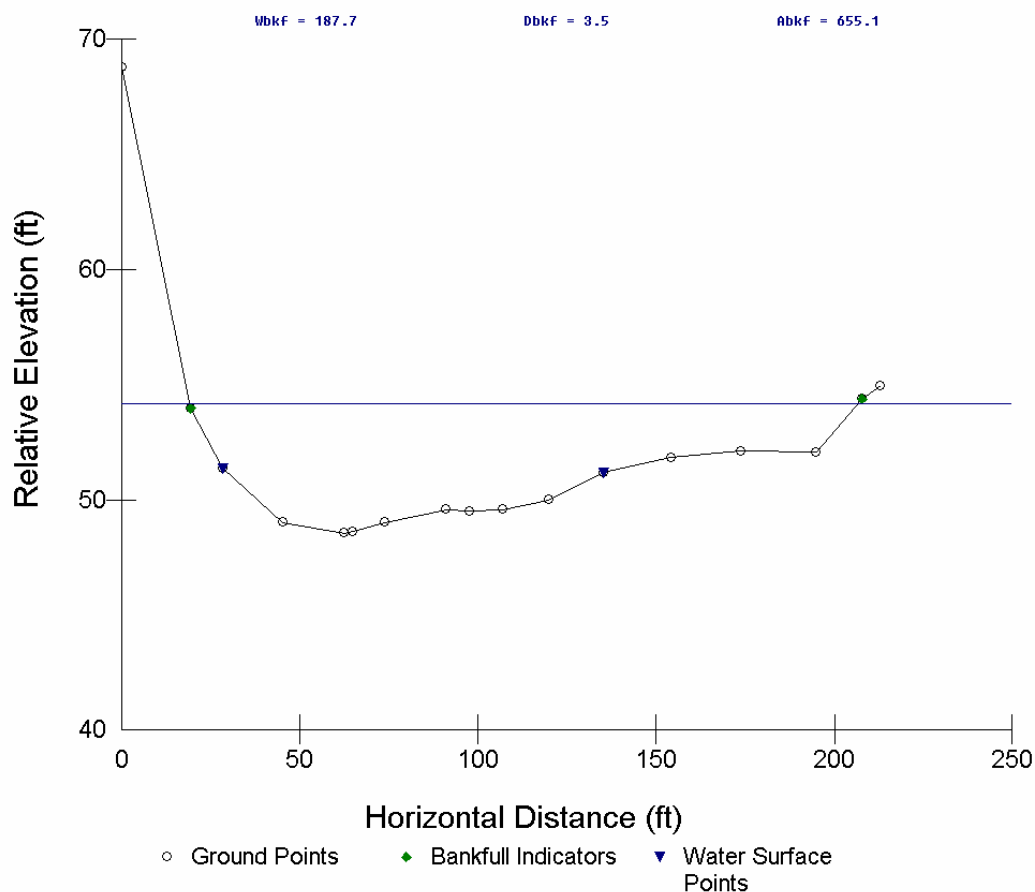
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 20 (Glide)

	2004
Bankfull Area (ft ²)	533
Width/Depth Ratio	38.5
Bankfull Width (ft)	143
Mean Depth (ft)	3.7

Reach: **BFR near Ovando (B)** Cross-Section: **21**Channel Unit: **Riffle**

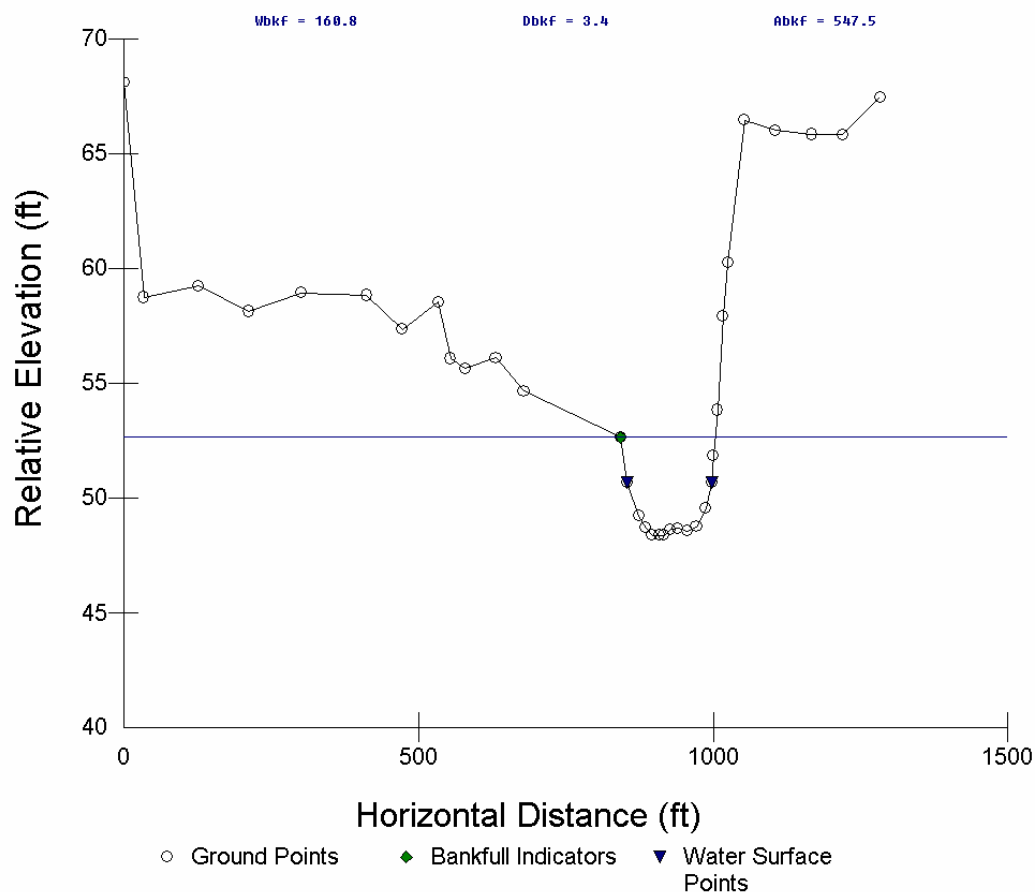
Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 21 (Riffle)

	2004
Bankfull Area (ft ²)	504
Width/Depth Ratio	64.7
Bankfull Width (ft)	180
Mean Depth (ft)	2.8

Reach: **BFR near Ovando (B)** Cross-Section: **22**Channel Unit: **Riffle**

Channel Cross-Section Summary Data
 BFR near Ovando, Cross-Section 22 (Riffle)

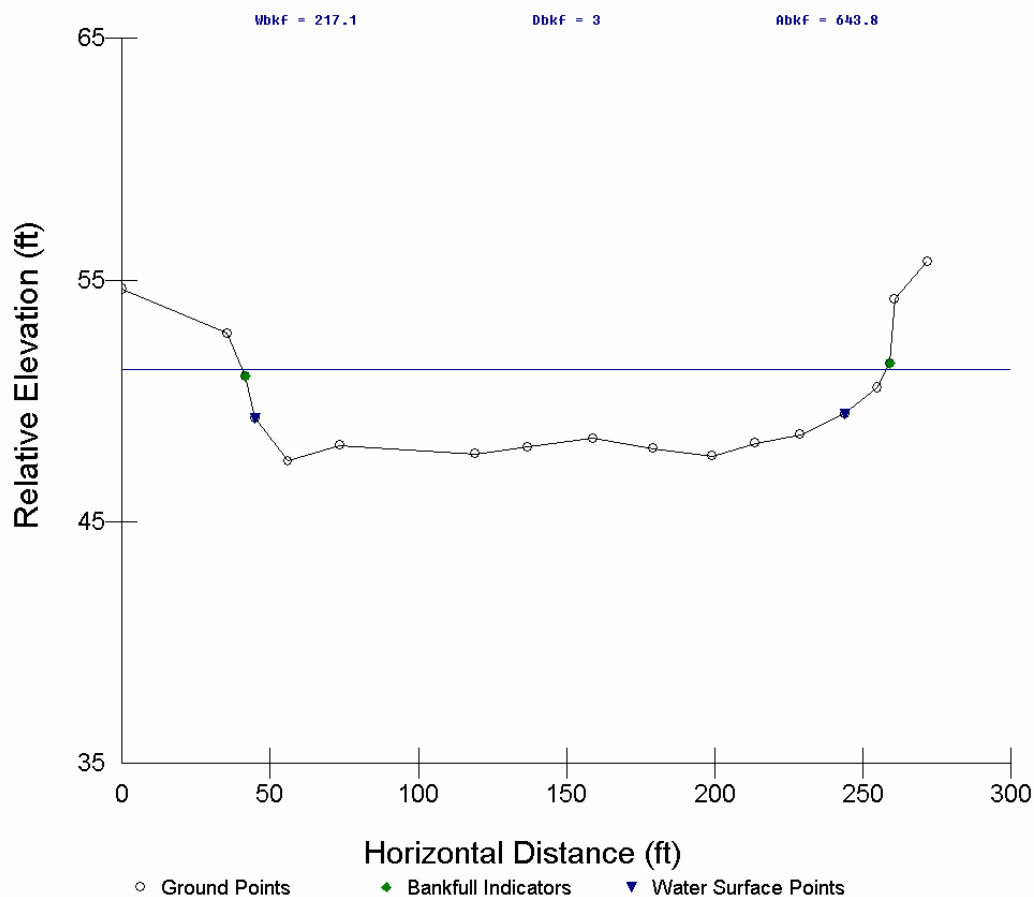
	2004
Bankfull Area (ft ²)	655
Width/Depth Ratio	53.8
Bankfull Width (ft)	188
Mean Depth (ft)	3.5

Reach: **BFR near Ovando (B)** Cross-Section: **23**Channel Unit: **Run**

Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 23 (Run)

	2004
Bankfull Area (ft ²)	548
Width/Depth Ratio	47.2
Bankfull Width (ft)	161
Mean Depth (ft)	3.4

Reach: **BFR near Ovando (B)** Cross-Section: **24** Channel Unit: **Riffle**

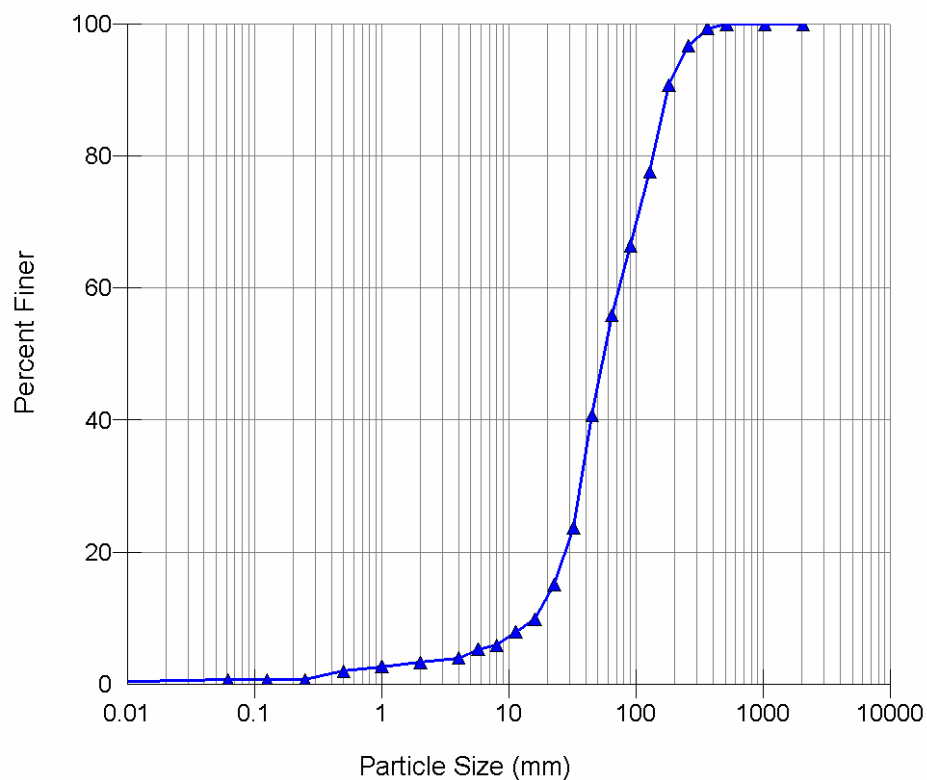


Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 24 (Riffle)

	2004
Bankfull Area (ft ²)	644
Width/Depth Ratio	73.1
Bankfull Width (ft)	217
Mean Depth (ft)	3.0

Reach: **BFR near Ovando (B)** Cross-Section: **16#1** Channel Unit: **Riffle**

Wolman Pebble Count

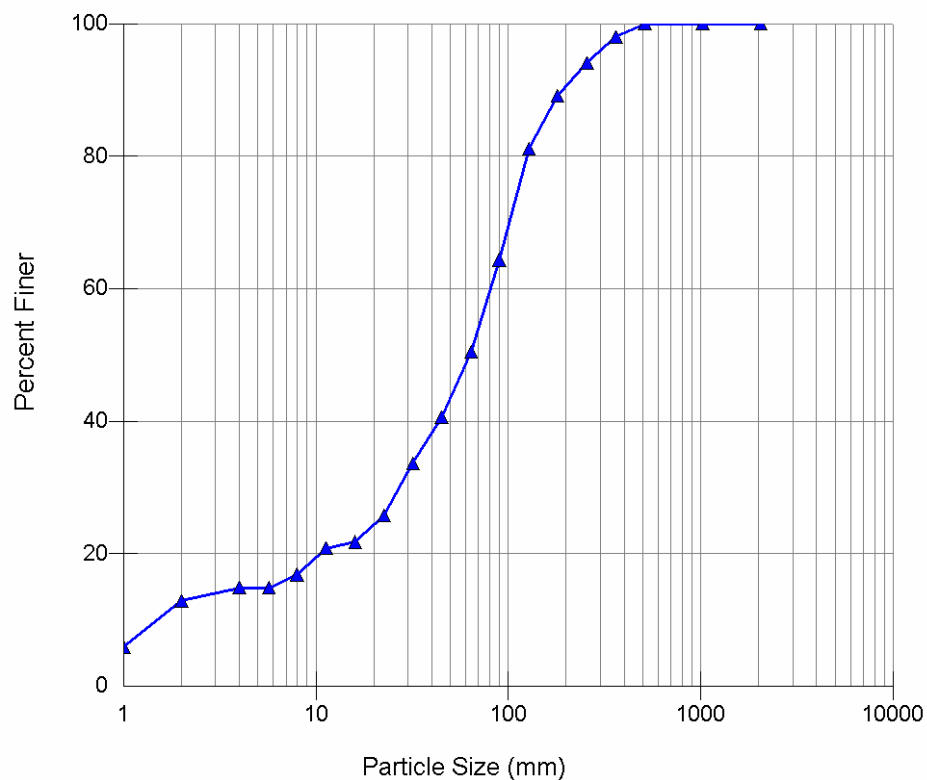


Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 16#1 (Riffle)

Size Class	XS 16#1 Riffle
D16	24
D35	41
D50	57
D84	153
D95	234
D100	512

Reach: **BFR near Ovando (B)** Cross-Section: **16#2** Channel Unit: **Riffle**

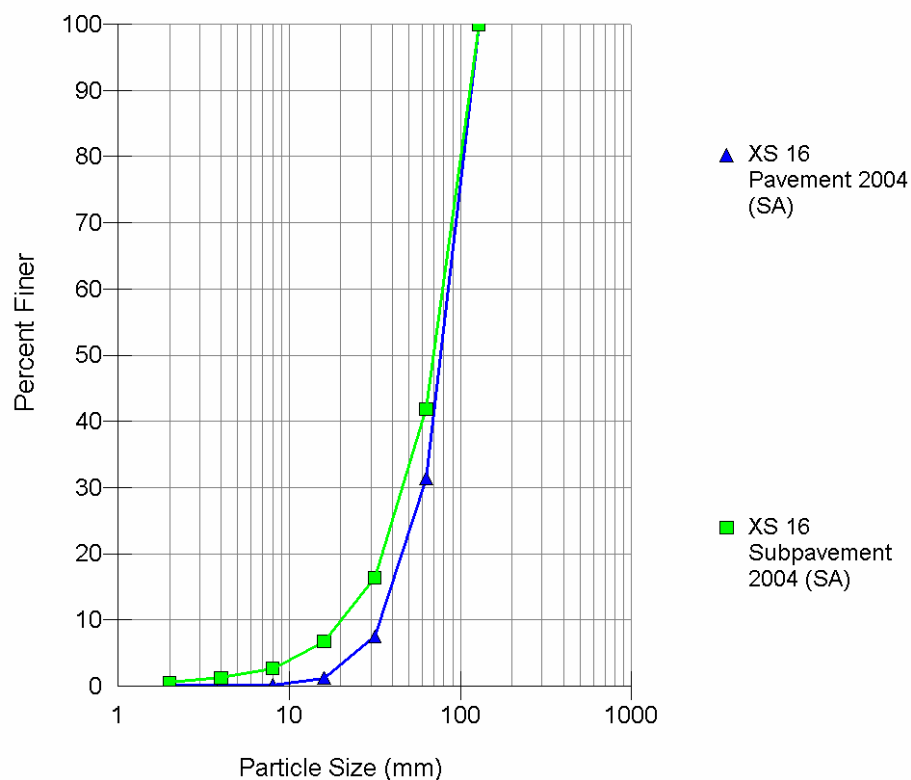
Wolman Pebble Count



Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 16#2 (Riffle)

Size Class	XS 16#2 Riffle
D16	7
D35	35
D50	63
D84	146
D95	281
D100	512

Substrate Pavement and Subpavement

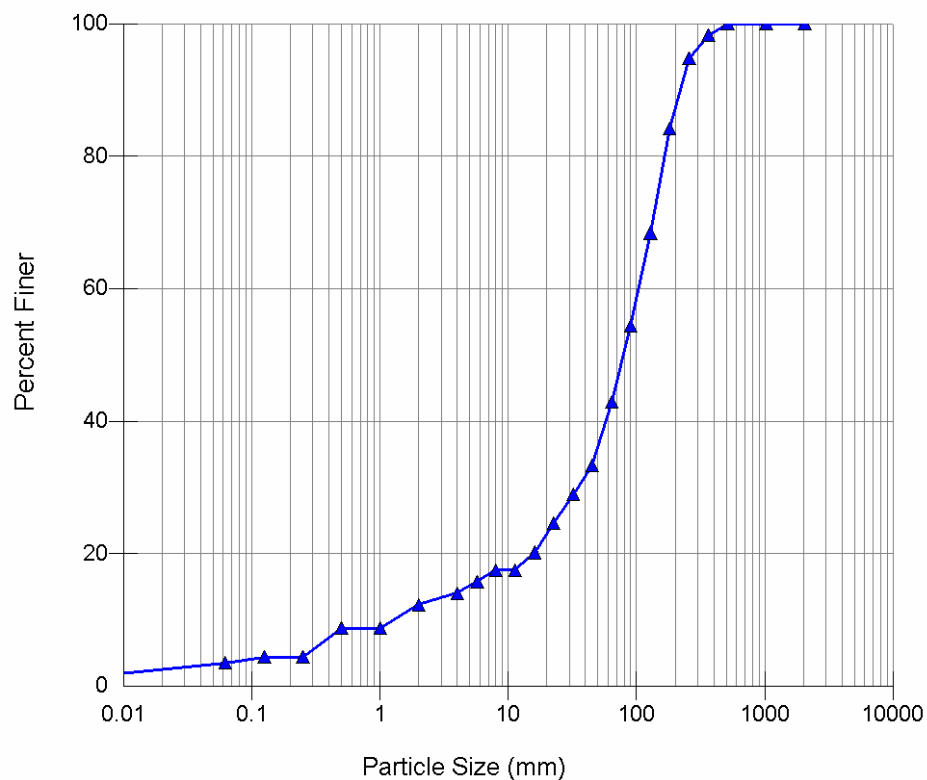


Substrate Pavement and Subpavement (mm)
BFR near Ovando, Cross-Section 16 (Glide)

Size Class	2004 Pavement	2004 Subpavement
D16	43	31
D35	66	54
D50	81	72
D84	113	110
D95	123	122
D100	128	128

Reach: **BFR near Ovando (B)** Cross-Section: **22** Channel Unit: **Riffle**

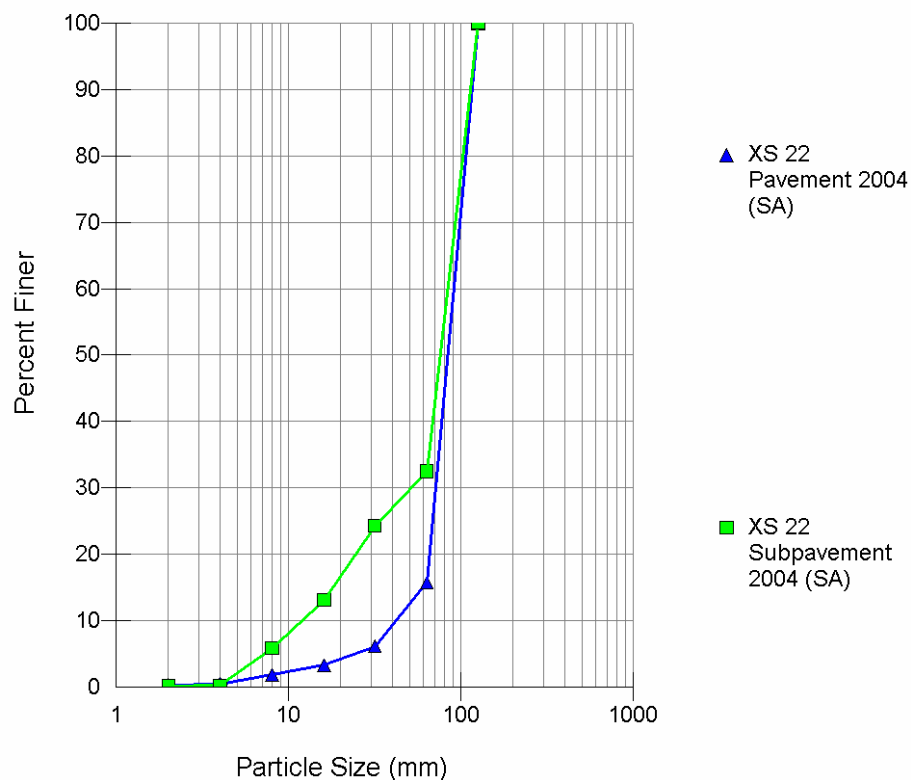
Wolman Pebble Count



Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 22 (Riffle)

Size Class	XS 22 Riffle
D16	6
D35	48
D50	80
D84	179
D95	264
D100	512

Substrate Pavement and Subpavement

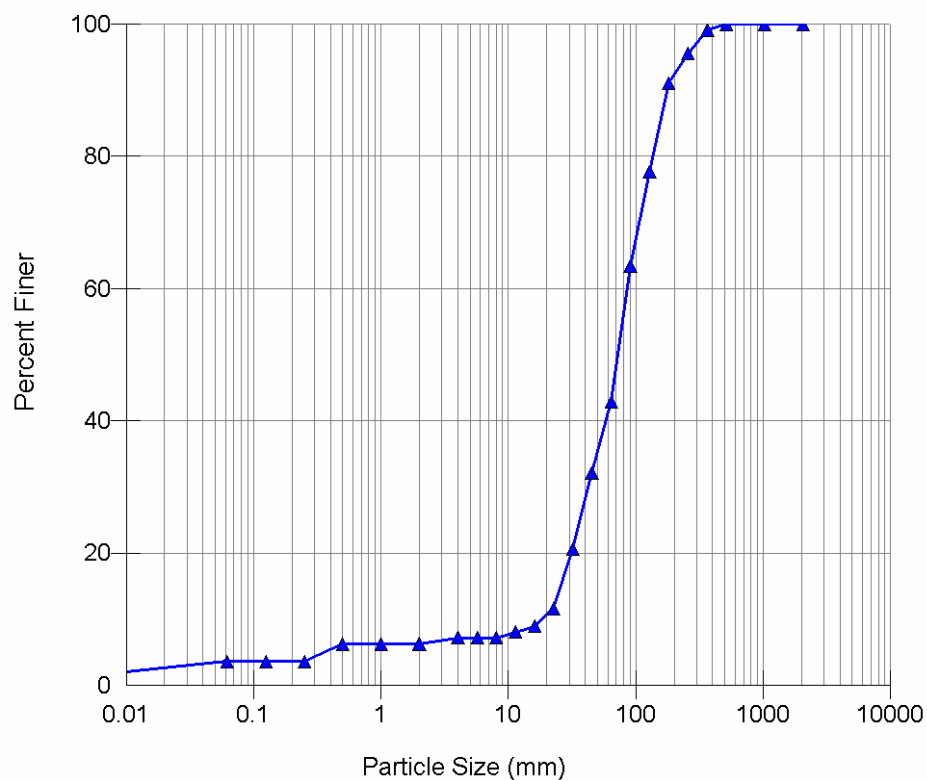


Substrate Pavement and Subpavement (mm)
BFR near Ovando, Cross-Section 22 (Riffle)

Size Class	2004 Pavement	2004 Subpavement
D16	63	20
D35	77	65
D50	88	79
D84	113	110
D95	121	120
D100	135	135

Reach: **BFR near Ovando (B)** Cross-Sections: **20** Channel Unit: **Riffle**

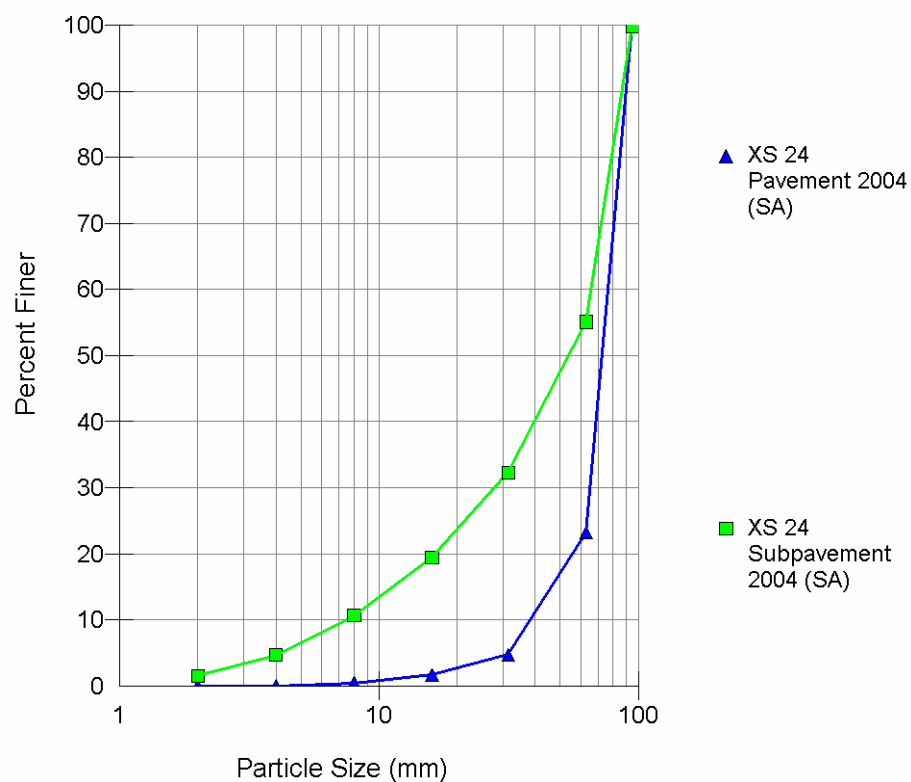
Wolman Pebble Count



Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 24 (Riffle)

Size Class	XS 24 Riffle
D16	27
D35	50
D50	73
D84	153
D95	247
D100	512

Substrate Pavement and Subpavement



Substrate Pavement and Subpavement (mm)
BFR near Ovando, Cross-Section 24 (Riffle)

Size Class	2004 Pavement	2004 Subpavement
D16	51	13
D35	68	35
D50	74	56
D84	88	84
D95	93	91
D100	95	95

Appendix K

BFR at Ovando F

REACH: BFR OVANDO F**Channel Cross-section Dimensions**

Reach	Cross-section Metric	Riffle 2004			Run 2004			Pool 2004			Glide 2004		
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
BFR Ovando F	Bankfull Area (ft ²)	495.8	549.7	603.5	663.0	663.0	663.0	694.7	711.6	728.5	727.8	566.4	711.8
	Width/Depth Ratio	49.3	60.5	67.7	46.1	46.1	46.1	38.5	42.3	41.2	48.0	54.7	40.3
	Mean Depth (ft)	2.6	3.0	3.5	3.8	3.8	3.8	4.0	4.1	4.3	3.1	3.3	3.9
	Max Depth (ft)	4.0	4.8	5.7	5.0	5.0	5.0	6.4	6.9	7.3	4.8	5.0	6.6
	Width (ft)	172.5	183.4	194.3	174.8	174.8	174.8	163.7	173.7	183.7	178.5	177.8	233.1

Channel Cross-section Dimensionless Ratios**2004 Data**

Dimensionless Metric	Min	Mean	Max
Wfpa / Wbkf	1.22	2.03	3.59
Abkf	495.81	544.05	603.49
Dmbkf	3.96	4.92	5.70
Dbkf	2.55	3.03	3.50
Wbkf	172.53	180.94	194.29
Pool Area / Abkf	1.28	1.31	1.34
Max Pool Depth / Dbkf	2.12	2.26	2.41
Mean Pool Depth / Dbkf	1.31	1.36	1.40
Pool Width / Wbkf	0.90	0.96	1.02
Run Area / Abkf	1.22	1.22	1.22
Max Run Depth / Dbkf	1.65	1.65	1.65
Mean Run Depth / Dbkf	1.25	1.25	1.25
Run Width / Wbkf	0.97	0.97	0.97
Glide Area / Abkf	1.34	1.38	1.43
Max Glide Depth / Dbkf	1.58	1.93	2.29
Mean Glide Depth / Dbkf	1.02	1.18	1.35
Glide Width / Wbkf	0.99	1.19	1.39

Channel Profile Dimensions and Dimensionless Ratios

2004 Data

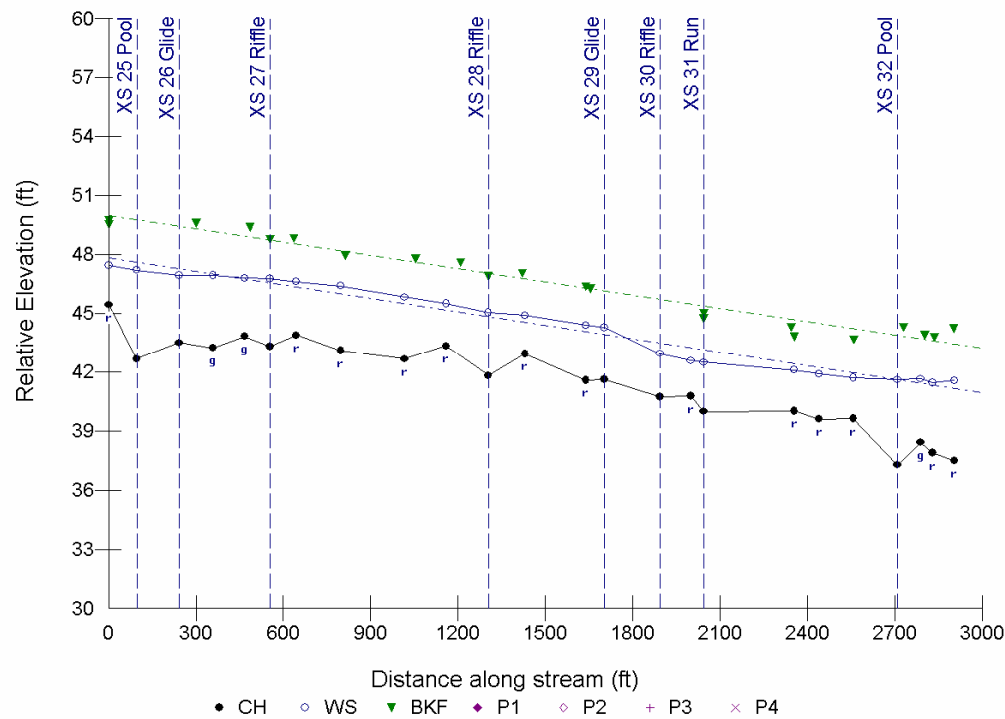
Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00116	0.00177	0.00242
S pool (ft/ft)	0.00073	0.00128	0.00183
S run (ft/ft)	0.00217	0.00261	0.00305
S glide (ft/ft)	0.00052	0.00079	0.00106
P - P (ft)	2608.45	2608.45	2608.45
P length (ft)	167.17	181.36	195.55
Dmax riffle (ft)	4.95	5.15	5.67
Dmax pool (ft)	6.58	6.83	7.08
Dmax run (ft)	5.4	5.46	5.52
Dmax glide (ft)	5.06	5.45	5.9
Low Bank Ht (ft)	3.84	4.03	4.22
Bankfull Slope (ft/ft)		0.00227	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.51	0.78	1.07
S pool / S bkf (ft/ft)	0.32	0.56	0.81
S run / S bkf (ft/ft)	0.96	1.15	1.34
S glide / S bkf (ft/ft)	0.23	0.35	0.47
P - P / W bkf (ft)	14.42	14.42	14.42
P length / W bkf (ft)	0.92	1.00	1.08
Dmax riffle / D bkf (ft)	1.63	1.70	1.87
Dmax pool / D bkf (ft)	2.17	2.25	2.34
Dmax run / D bkf (ft)	1.78	1.80	1.82
Dmax glide / D bkf (ft)	1.67	1.80	1.95
Low Bank Ht / Dmax riff (ft)	0.75	0.78	0.82
Bankfull Slope (ft/ft)		0.00227	

Channel Planform Dimensions and Dimensionless Ratios

No Data

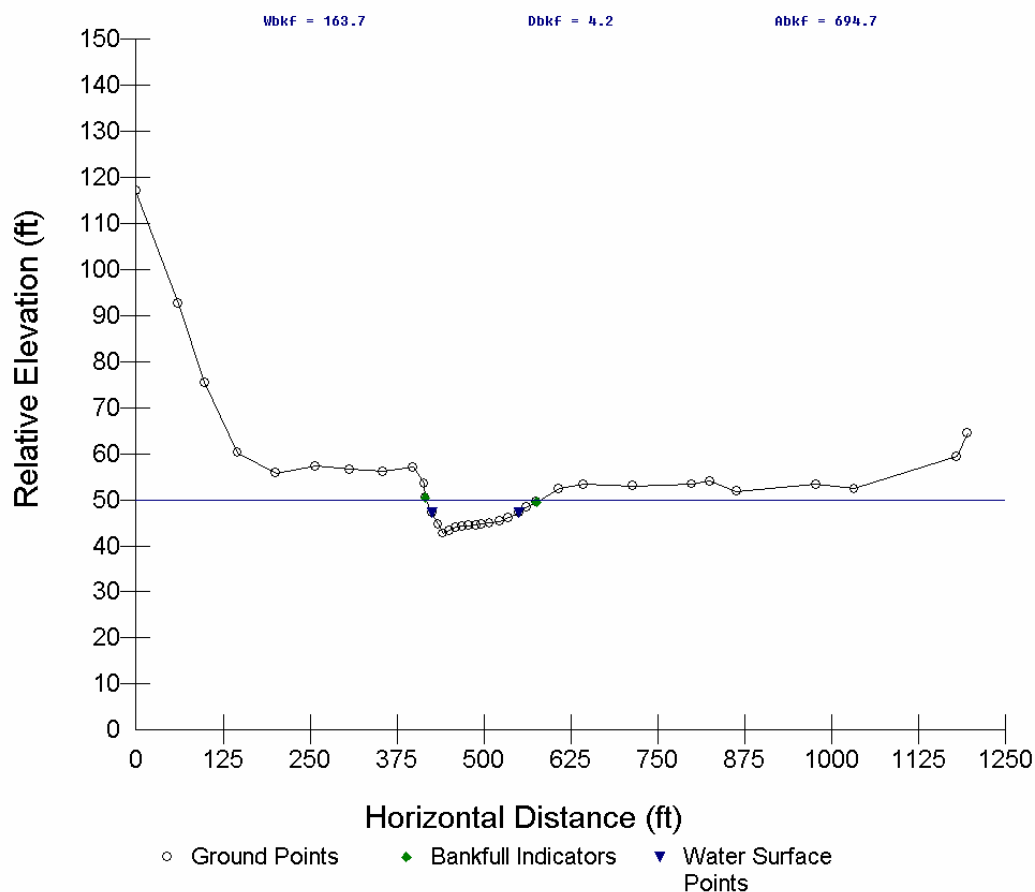
BFR near Ovando F Reach 2004



Profile Dimensions Metric	Min	Mean	Max
S riffle (ft/ft)	0.00116	0.00177	0.00242
S pool (ft/ft)	0.00073	0.00128	0.00183
S run (ft/ft)	0.00217	0.00261	0.00305
S glide (ft/ft)	0.00052	0.00079	0.00106
P - P (ft)	2608.45	2608.45	2608.45
P length (ft)	167.17	181.36	195.55
Dmax riffle (ft)	4.95	5.15	5.67
Dmax pool (ft)	6.58	6.83	7.08
Dmax run (ft)	5.4	5.46	5.52
Dmax glide (ft)	5.06	5.45	5.9
Low Bank Ht (ft)	3.84	4.03	4.22
Bankfull Slope (ft/ft)		0.00227	

Profile Dimensionless Ratios	Min	Mean	Max
S riffle / S bkf (ft/ft)	0.51	0.78	1.07
S pool / S bkf (ft/ft)	0.32	0.56	0.81
S run / S bkf (ft/ft)	0.96	1.15	1.34
S glide / S bkf (ft/ft)	0.23	0.35	0.47
P - P / W bkf (ft)	14.42	14.42	14.42
P length / W bkf (ft)	0.92	1.00	1.08
Dmax riffle / D bkf (ft)	1.63	1.70	1.87
Dmax pool / D bkf (ft)	2.17	2.25	2.34
Dmax run / D bkf (ft)	1.78	1.80	1.82
Dmax glide / D bkf (ft)	1.67	1.80	1.95
Low Bank Ht / Dmax riff (ft)	0.75	0.78	0.82
Bankfull Slope (ft/ft)		0.00227	

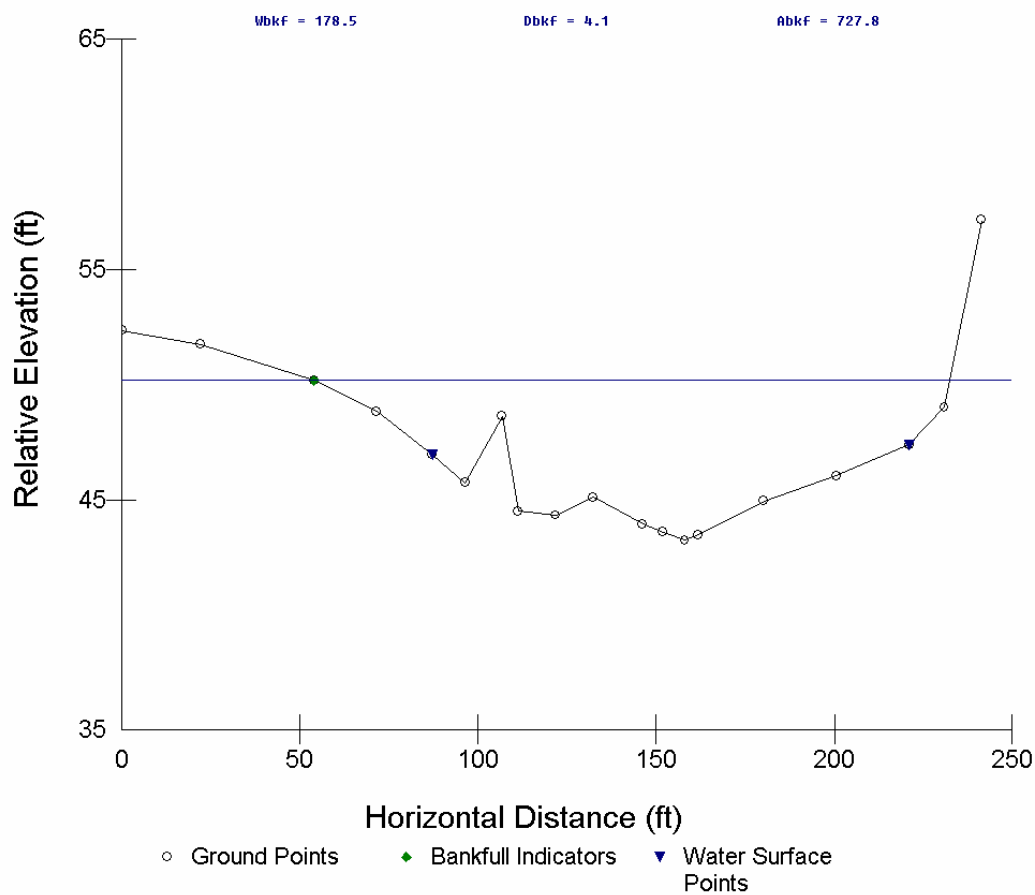
Reach: **BFR near Ovando (F)** Cross-Section: **25** Channel Unit: **Pool**



Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 25 (Pool)

	2004
Bankfull Area (ft ²)	695
Width/Depth Ratio	38.5
Bankfull Width (ft)	164
Mean Depth (ft)	4.3

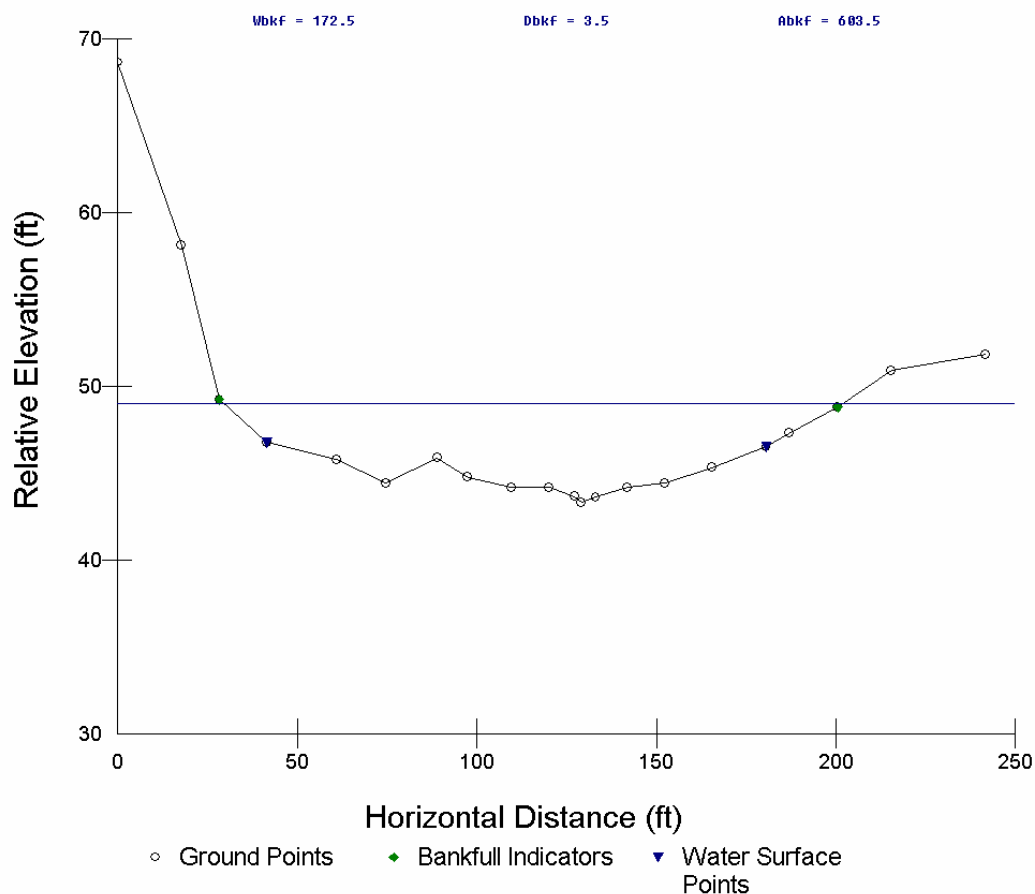
Reach: **BFR near Ovando (F)** Cross-Section: **26** Channel Unit: **Glide**



Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 26 (Glide)

	2004
Bankfull Area (ft ²)	728
Width/Depth Ratio	43.8
Bankfull Width (ft)	179
Mean Depth (ft)	4.1

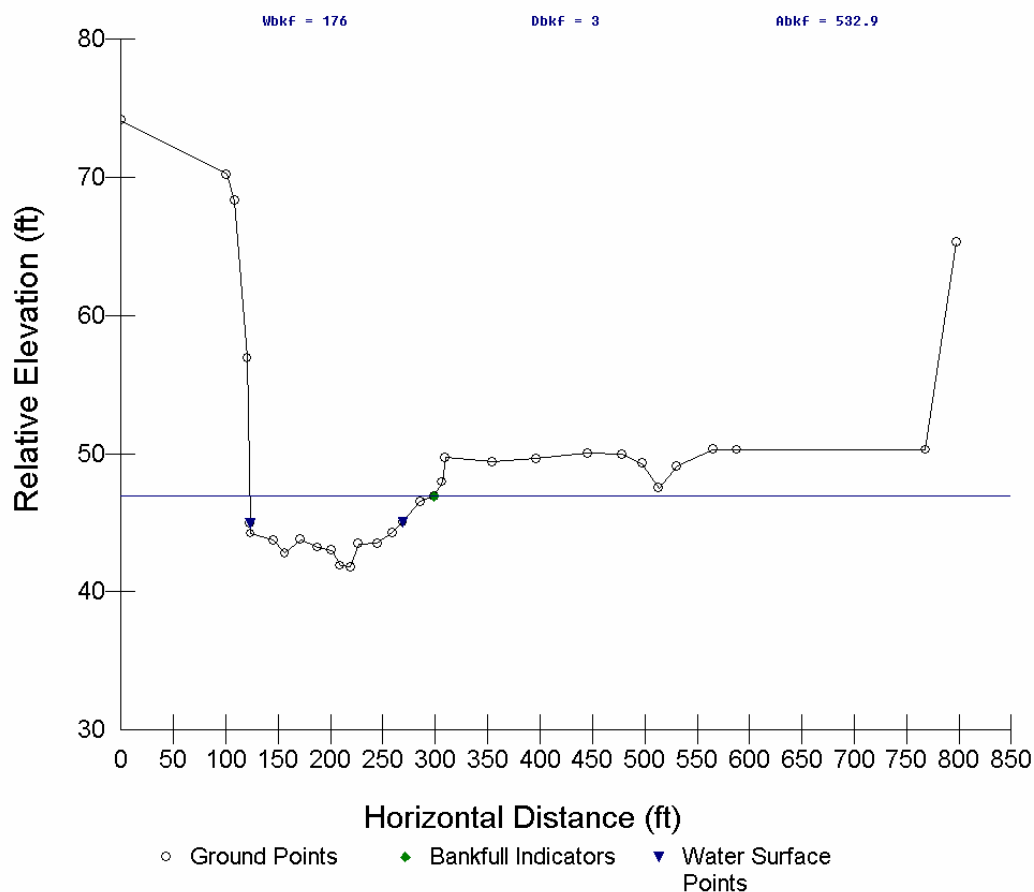
Reach: **BFR near Ovando (F)** Cross-Section: **27** Channel Unit: **Riffle**



Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 27 (Riffle)

	2004
Bankfull Area (ft ²)	603
Width/Depth Ratio	49.3
Bankfull Width (ft)	173
Mean Depth (ft)	3.5

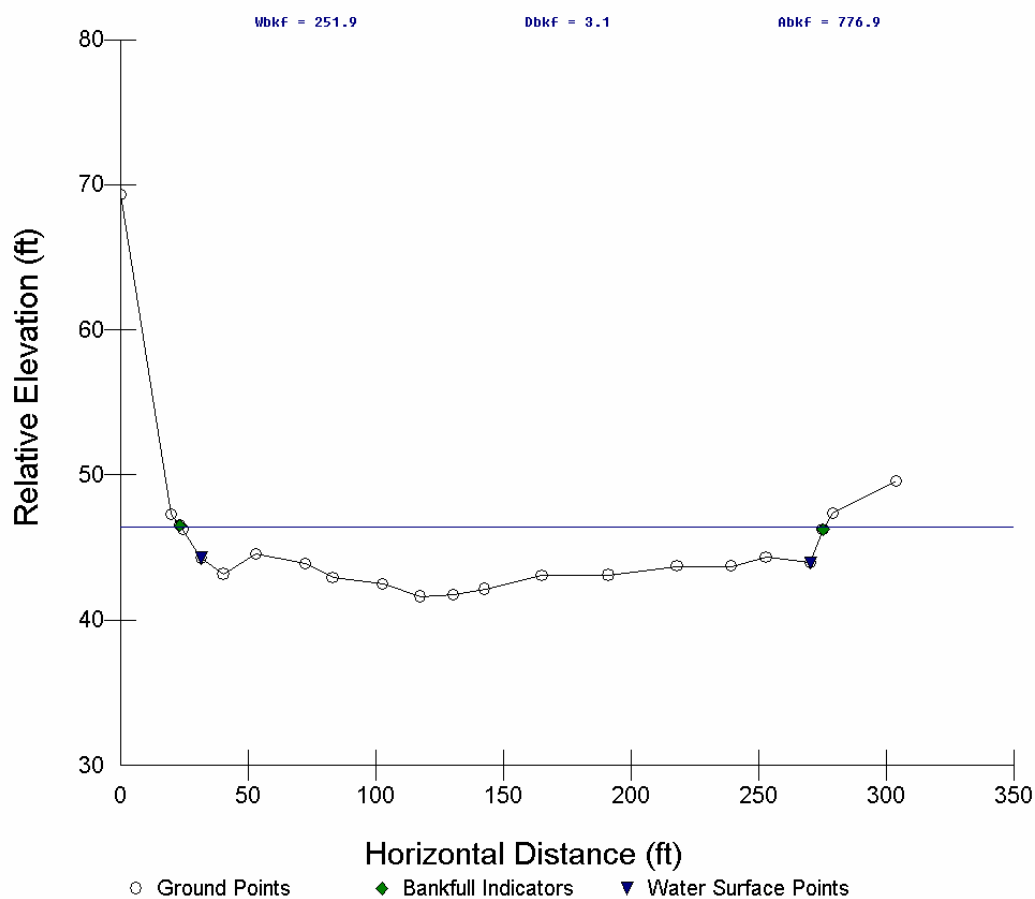
Reach: **BFR near Ovando (F)** Cross-Section: **28** Channel Unit: **Riffle**



Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 28 (Riffle)

	2004
Bankfull Area (ft ²)	533
Width/Depth Ratio	58.1
Bankfull Width (ft)	176
Mean Depth (ft)	3.0

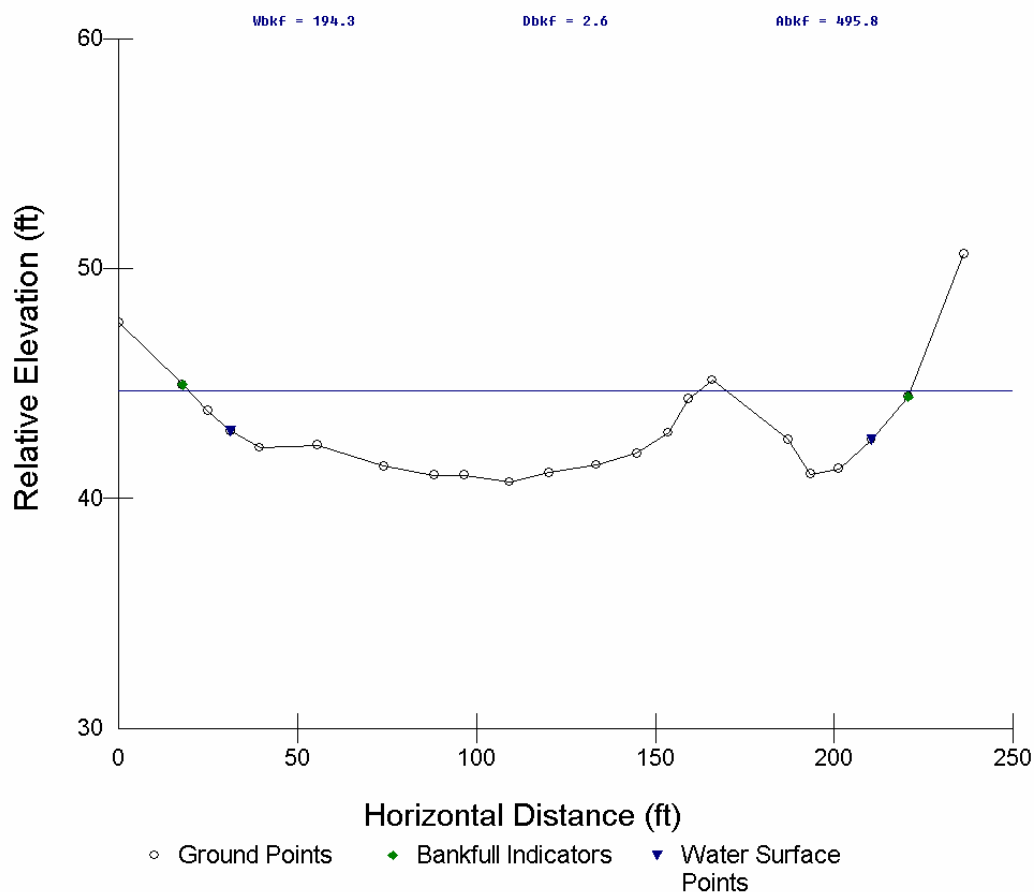
Reach: **BFR near Ovando (F)** Cross-Section: **29** Channel Unit: **Glide**



Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 29 (Glide)

	2004
Bankfull Area (ft ²)	777
Width/Depth Ratio	81.8
Bankfull Width (ft)	252
Mean Depth (ft)	3.1

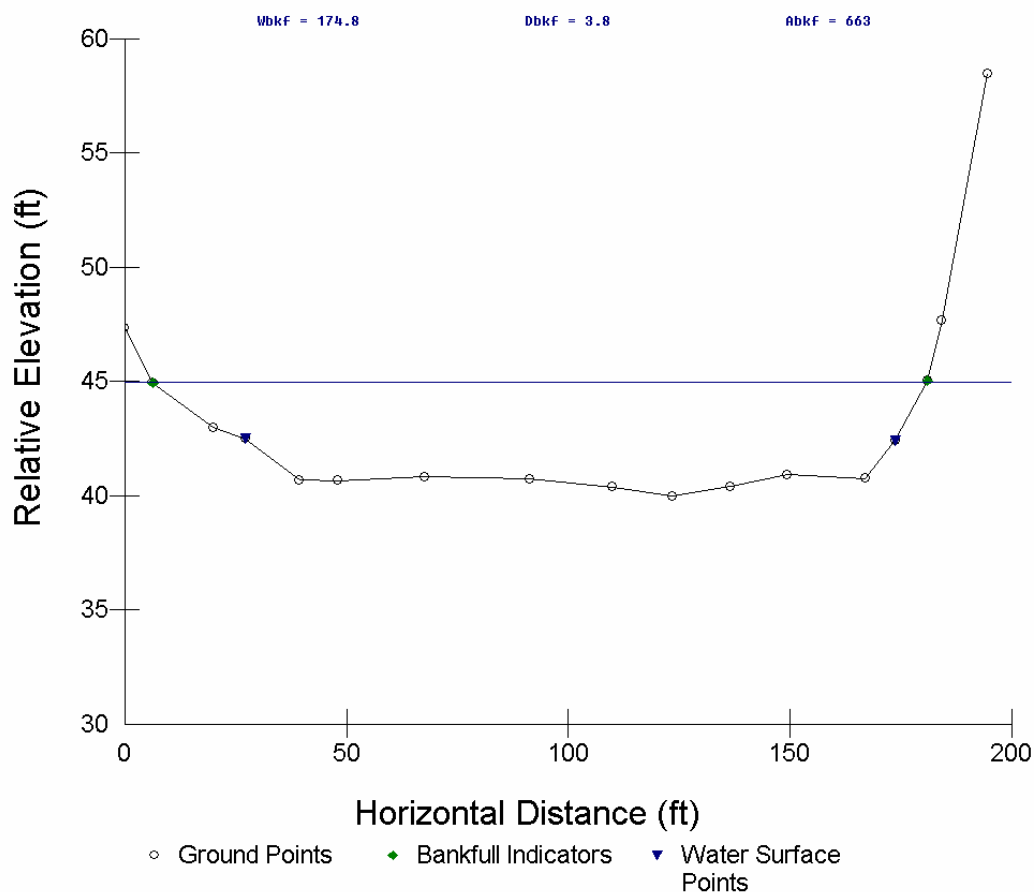
Reach: **BFR near Ovando (F)** Cross-Section: **30** Channel Unit: **Riffle**



Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 30 (Riffle)

	2004
Bankfull Area (ft ²)	496
Width/Depth Ratio	76.2
Bankfull Width (ft)	194
Mean Depth (ft)	2.6

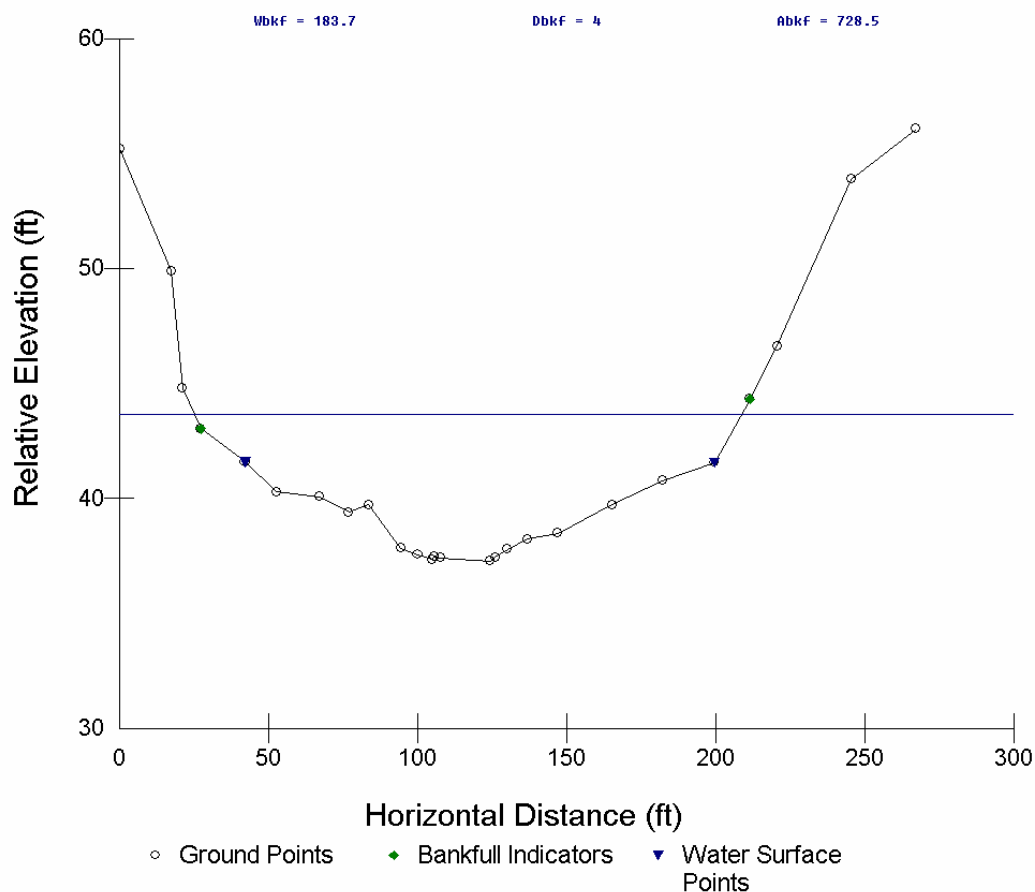
Reach: **BFR near Ovando (F)** Cross-Section: **31** Channel Unit: **Run**



Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 31 (Run)

	2004
Bankfull Area (ft ²)	663
Width/Depth Ratio	46.1
Bankfull Width (ft)	175
Mean Depth (ft)	3.8

Reach: **BFR near Ovando (F)** Cross-Section: **32** Channel Unit: **Pool**

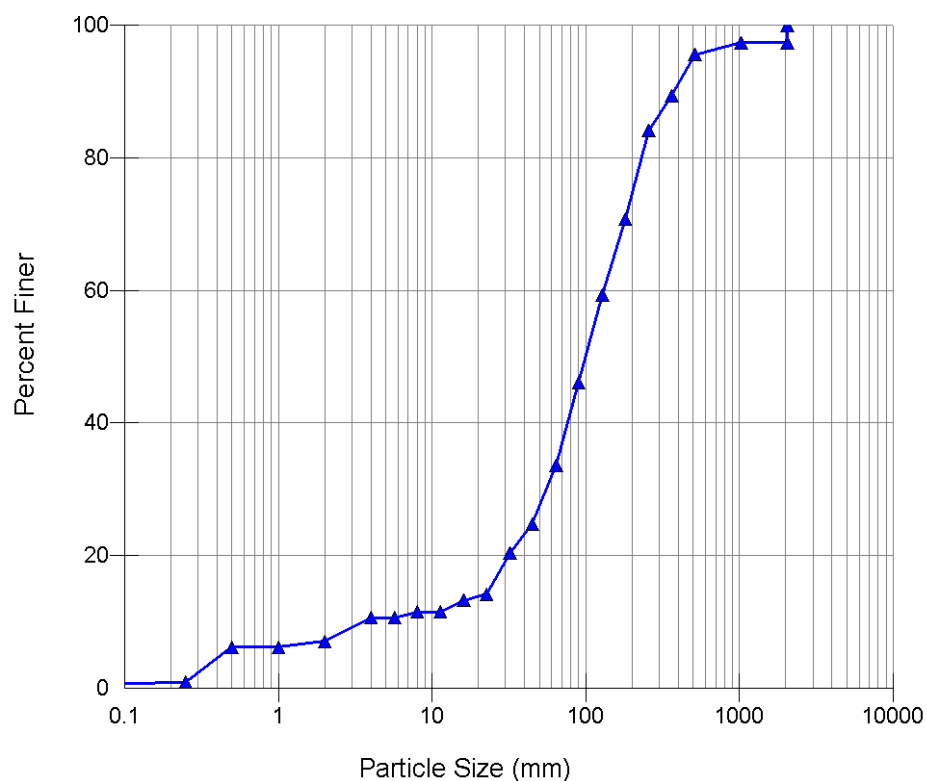


Channel Cross-Section Summary Data
BFR near Ovando, Cross-Section 32 (Pool)

	2004
Bankfull Area (ft ²)	728
Width/Depth Ratio	46.3
Bankfull Width (ft)	184
Mean Depth (ft)	4.0

Reach: **BFR near Ovando (F)** Cross-Sections: **27** Channel Unit: **Riffle**

Wolman Pebble Count

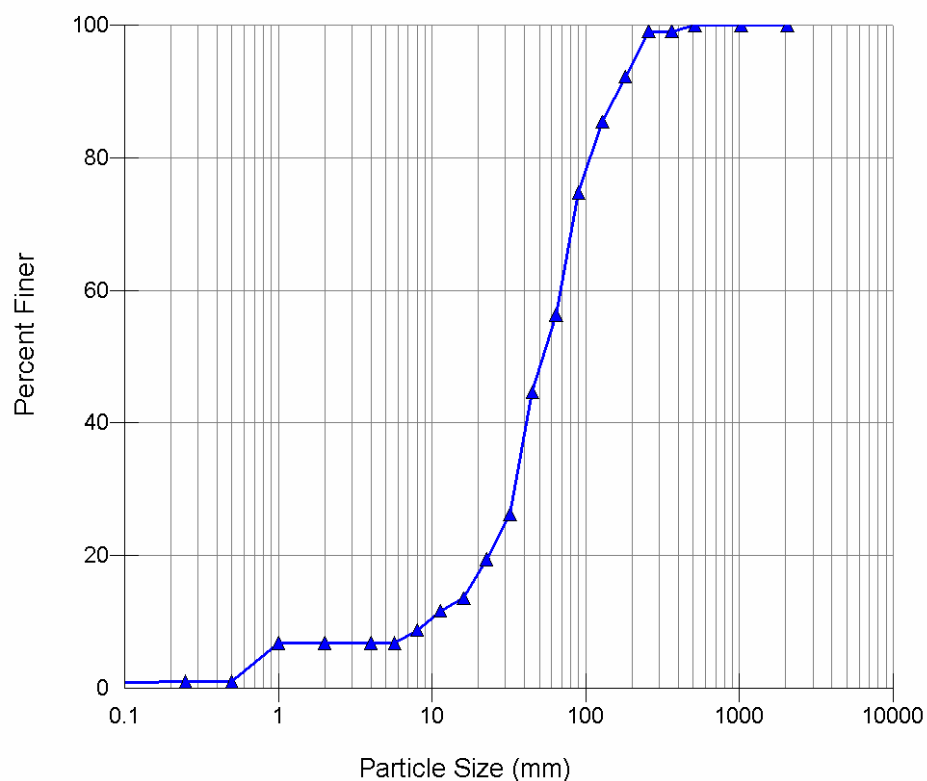


Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 27 (Riffle)

Size Class	XS 27 Riffle
D16	25
D35	67
D50	101
D84	256
D95	498
D100	Bedrock

Reach: **BFR near Ovando (F)** Cross-Sections: **30#1** Channel Unit: **Riffle**

Wolman Pebble Count

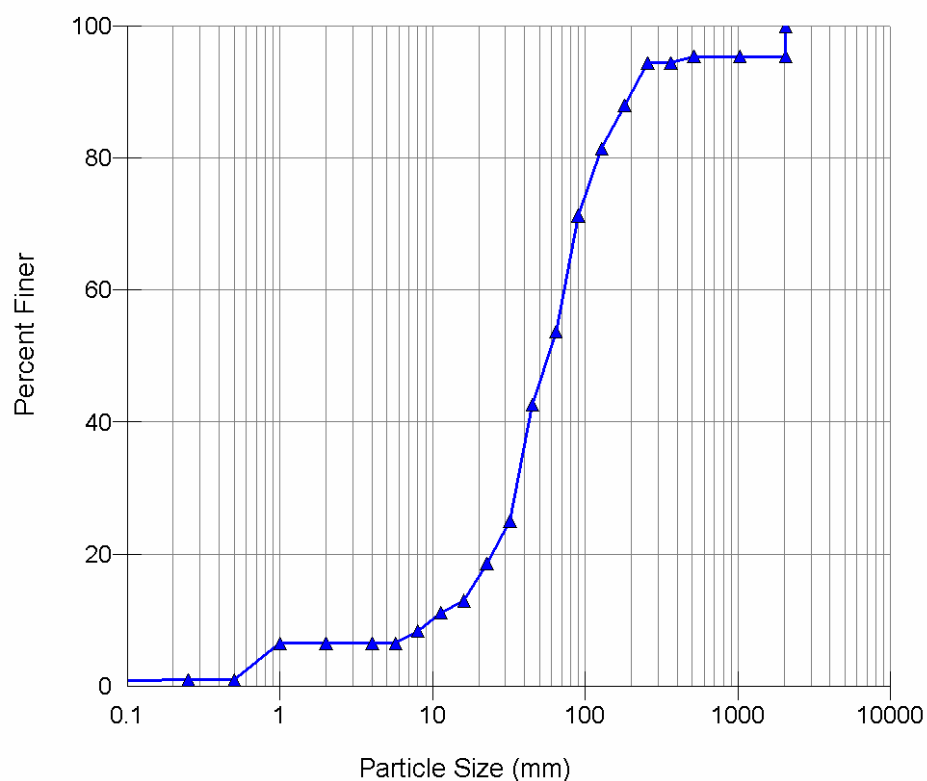


Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 30#1 (Riffle)

Size Class	XS 30#1 Riffle
D16	19
D35	38
D50	54
D84	123
D95	211
D100	512

Reach: **BFR near Ovando (F)** Cross-Sections: **30#2** Channel Unit: **Riffle**

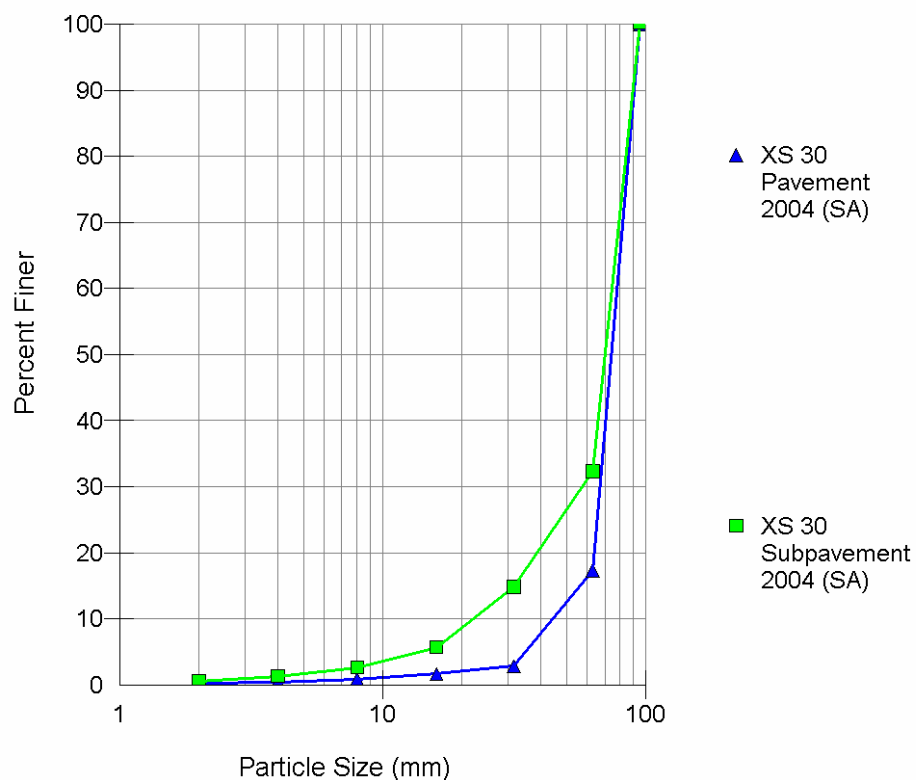
Wolman Pebble Count



Wolman Pebble Count Results (mm)
BFR near Ovando, Cross-Section 30 #2 (Riffle)

Size Class	XS 30#2 Riffle
D16	20
D35	39
D50	58
D84	148
D95	452
D100	Bedrock

Substrate Pavement and Subpavement

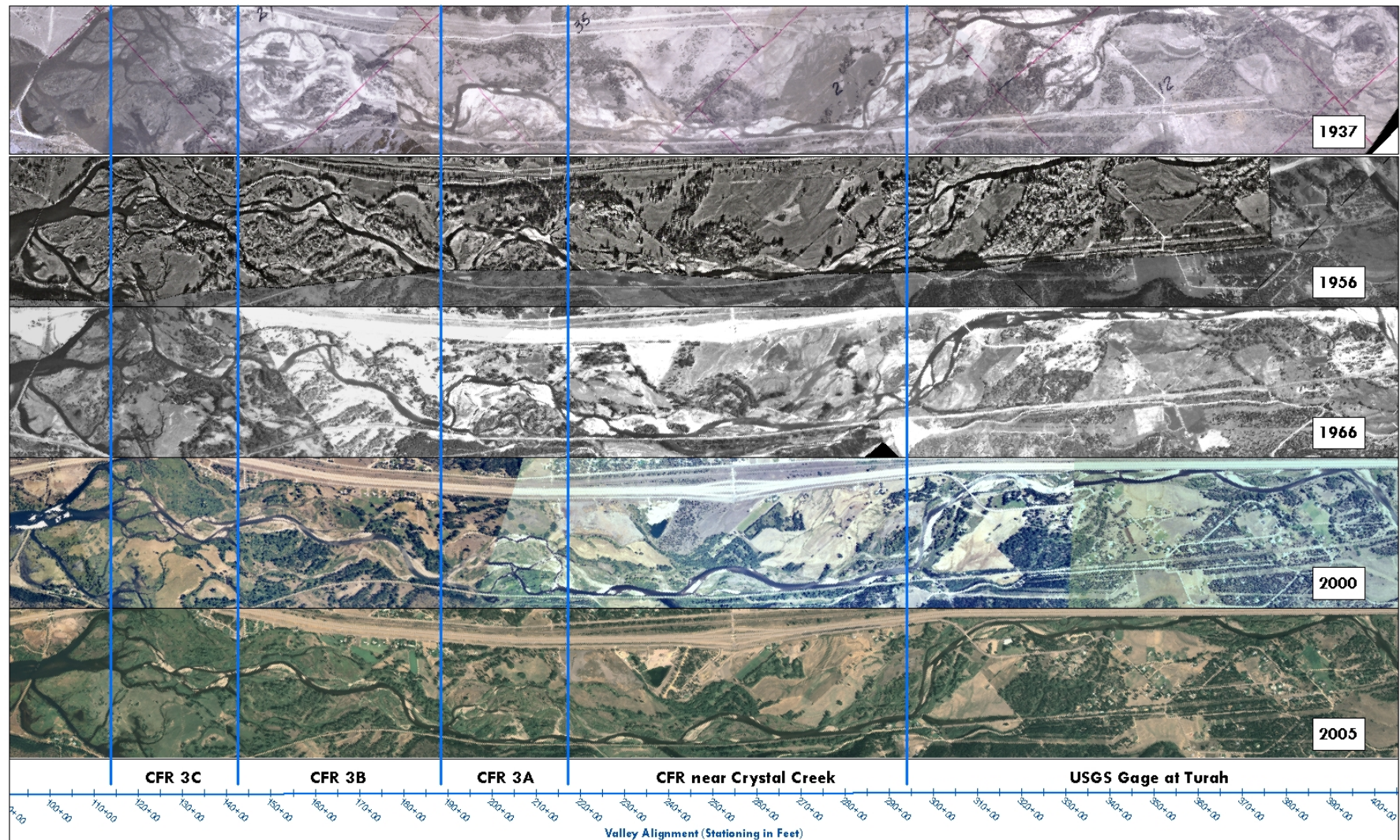


Substrate Pavement and Subpavement (mm)
BFR near Ovando, Cross-Section 30 (Riffle)

Size Class	2004 Pavement	2004 Subpavement
D16	60	34
D35	70	64
D50	76	71
D84	89	87
D95	93	93
D100	145	145

Appendix L

CFR Meander Geometry

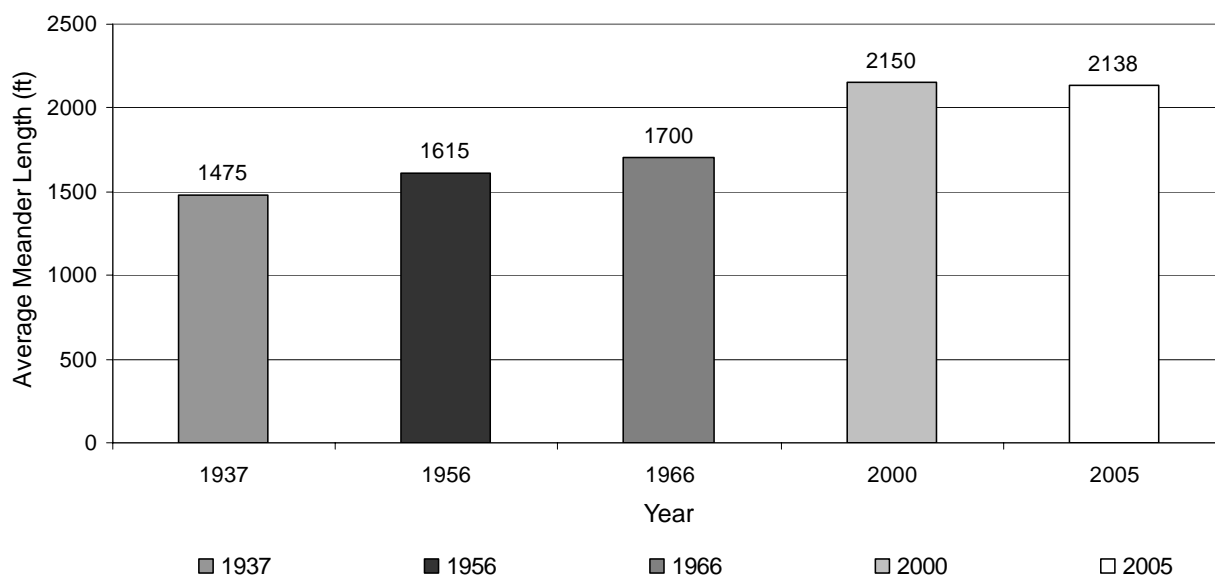


Aerial Photo Time Series of the Clark Fork River from Turah Bridge Downstream to Milltown Reservoir

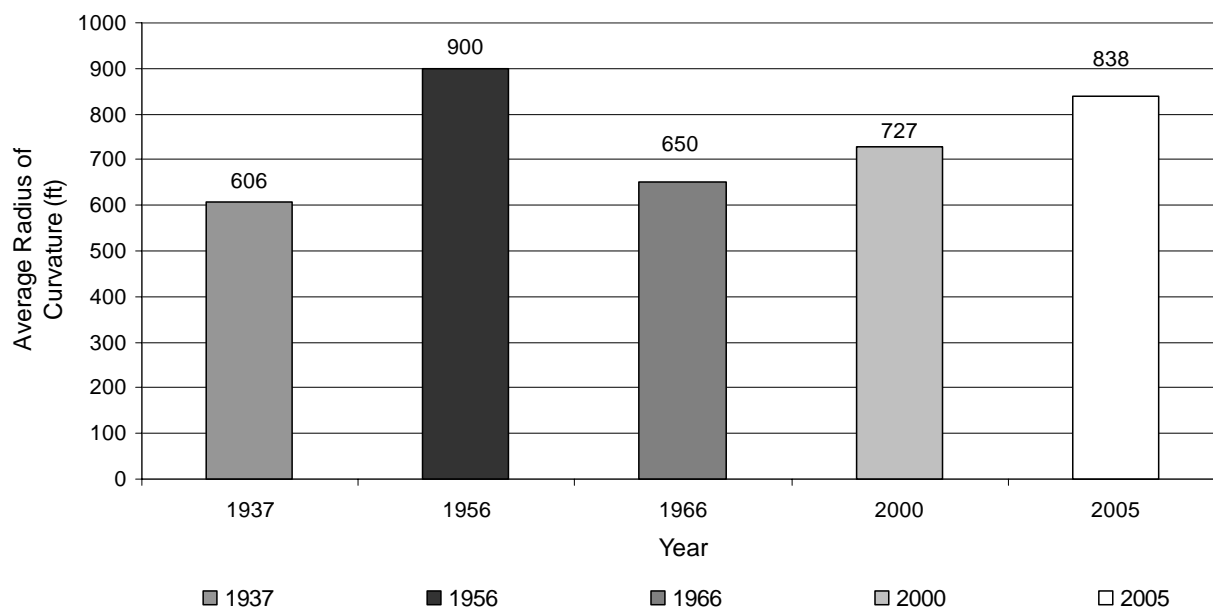
Summary of channel planform metrics in CFR 3B for years 1937, 1956, 1966, 2000 and 2005.

Year	Planform Metric (ft)			
	Meander Length (ft)	Radius of Curvature (ft)	Belt Width (ft)	Sinuosity (ft/ft)
1937	1475	606	1264	1.35
1956	1615	900	414	1.19
1966	1700	650	522	1.28
2000	2150	727	572	1.17
2005	2138	838	608	1.23

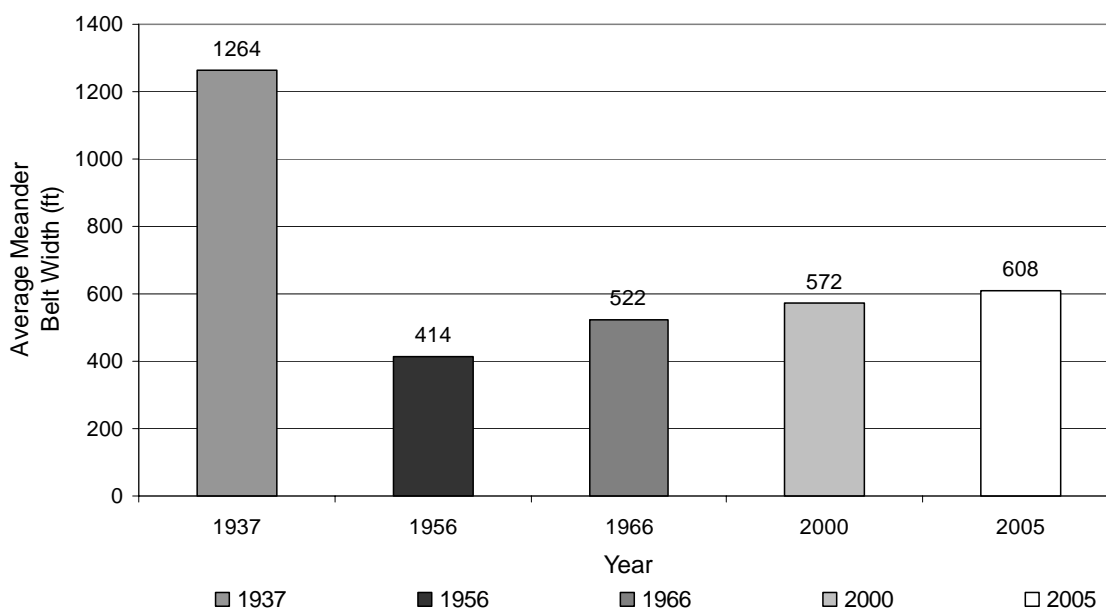
Average meander length in CFR 3B for years 1937, 1956, 1966, 2000 and 2005.
Results based on air photo interpretation.



Average radius of curvature in CFR 3B for years 1937, 1956, 1966, 2000 and 2005. Results based on air photo interpretation.



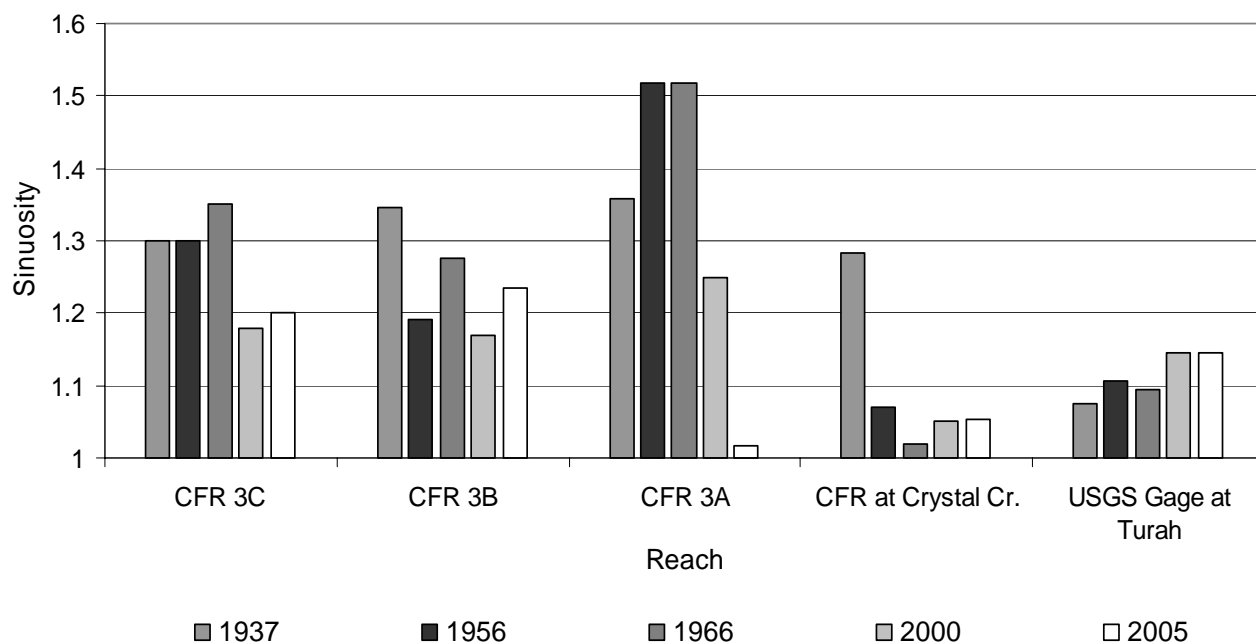
Average meander belt width in CFR 3B for years 1937, 1956, 1966, 2000 and 2005. Results based on air photo interpretation.



Summary of channel sinuosity data for CFR 3C, CFR 3B, CFR 3A, CFR at Crystal Creek and CFR at Turah for years 1937, 1956, 1966, 2000 and 2005.

Year	Reach				
	CFR at Turah, MT	CFR at Crystal Creek	CFR 3A	CFR 3B	CFR 3C
1937	1.08	1.28	1.36	1.35	1.30
1956	1.11	1.07	1.52	1.19	1.30
1966	1.10	1.02	1.52	1.28	1.35
2000	1.15	1.05	1.25	1.17	1.18
2005	1.15	1.05	1.02	1.23	1.20

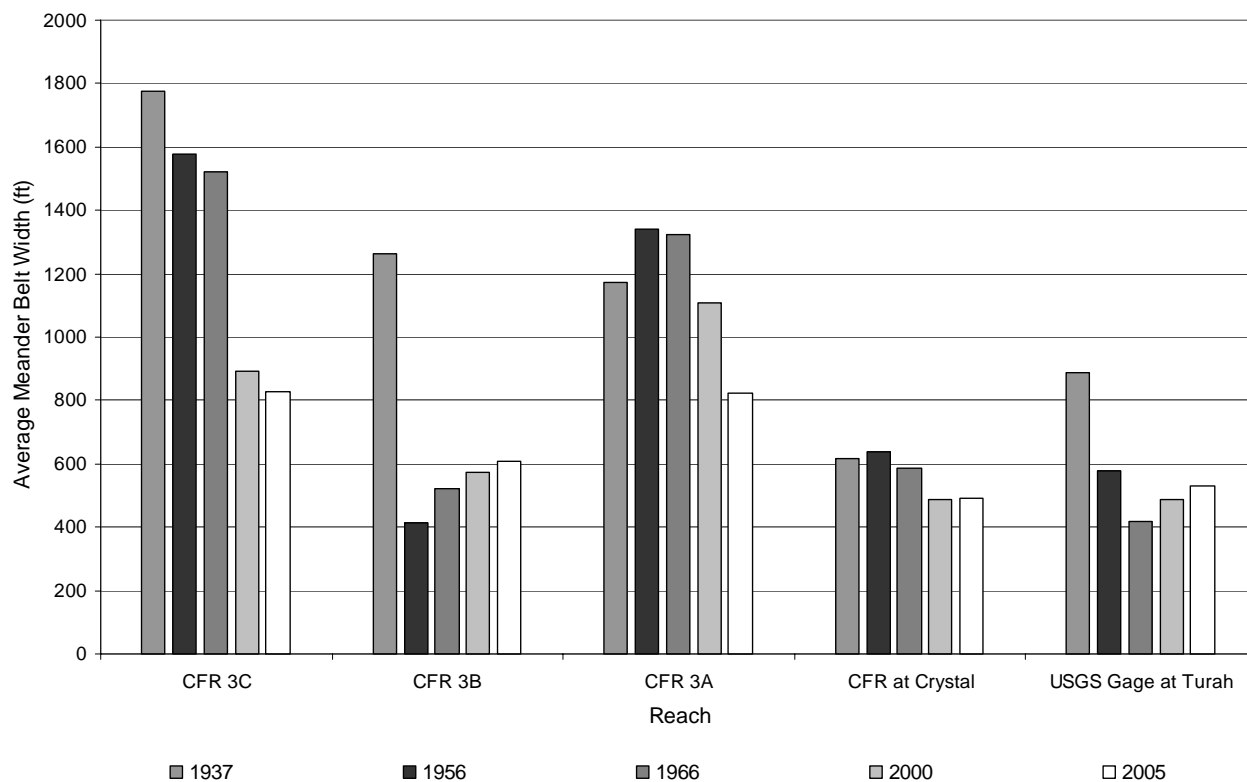
Channel sinuosity values for CFR 3C, CFR 3B, CFR 3A, CFR at Crystal Creek and CFR at Turah for Years 1937, 1956, 1966, 2000 and 2005.



Summary of meander belt width values for CFR 3C, CFR 3B, CFR 3A, CFR at Crystal Creek and CFR at Turah for years 1937, 1956, 1966, 2000 and 2005. Values in feet.

Year	Reach				
	CFR at Turah, MT	CFR at Crystal Creek	CFR 3A	CFR 3B	CFR 3C
1937	888	618	1171	1264	1775
1956	579	638	1342	414	1579
1966	418	588	1325	522	1521
2000	489	486	1108	572	892
2005	529	492	825	608	829

Meander belt width values for CFR 3C, CFR 3B, CFR 3A, CFR at Crystal Creek and CFR at Turah for Years 1937, 1956, 1966, 2000 and 2005.



Summary of channel planform metrics in CFR near Clinton, MT for years 1937, 1948, 1966, 1995 and 2005.

Year	Planform Metric (ft)			
	Meander Length (ft)	Radius of Curvature (ft)	Belt Width (ft)	Sinuosity (ft/ft)
1937	1795	737	584	n/a [†]
1948	2329	722	684	1.11
1966	2355	586	834	1.18
1995	2717	811	939	1.14
2005	2778	755	942	1.22

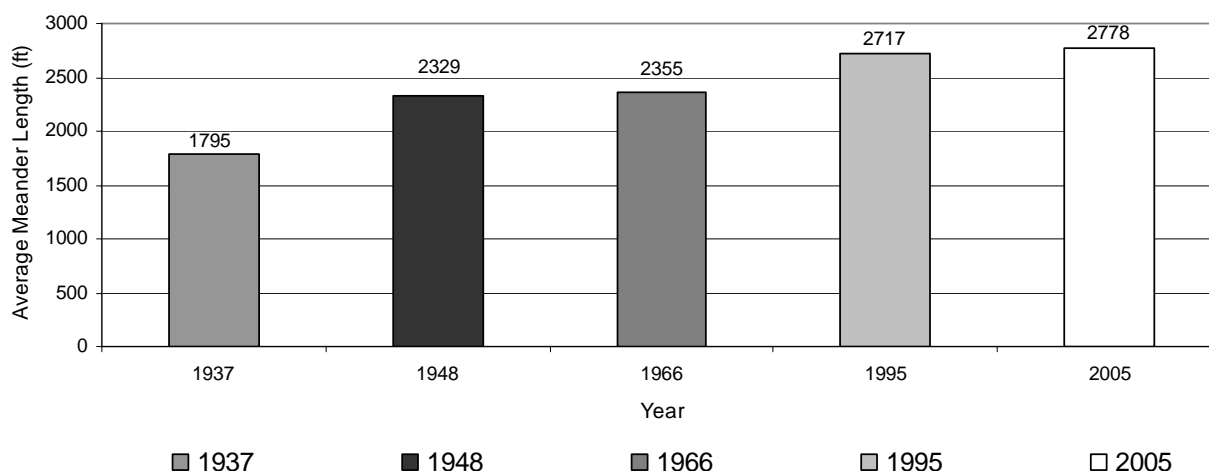
Summary of channel planform metrics in CFR near Clinton, MT for years 1937, 1948, 1966, 1995 and 2005.

Year	Planform Dimensionless Ratios*			
	Meander Length	Radius of Curvature	Belt Width	Sinuosity (ft/ft)
1937	10.68	4.39	3.48	n/a [†]
1948	13.86	4.30	4.07	1.11
1966	14.02	3.49	4.96	1.18
1995	16.17	4.83	5.59	1.14
2005	16.54	4.49	5.61	1.22

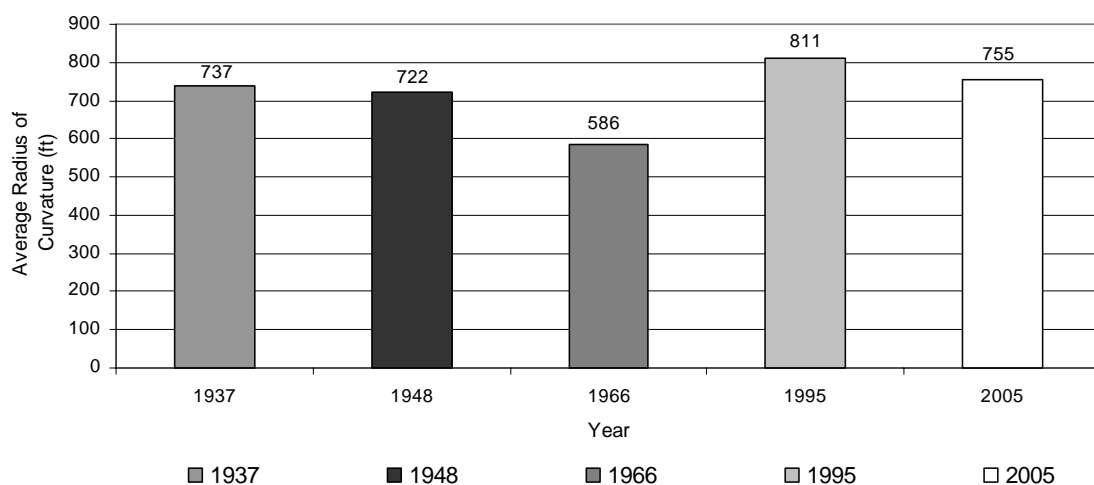
[†] 1937 aerial photograph only captures downstream meander sequence.

*An average riffle width of 168 ft, measured in the 2006 survey, was used to develop the dimensionless ratios.

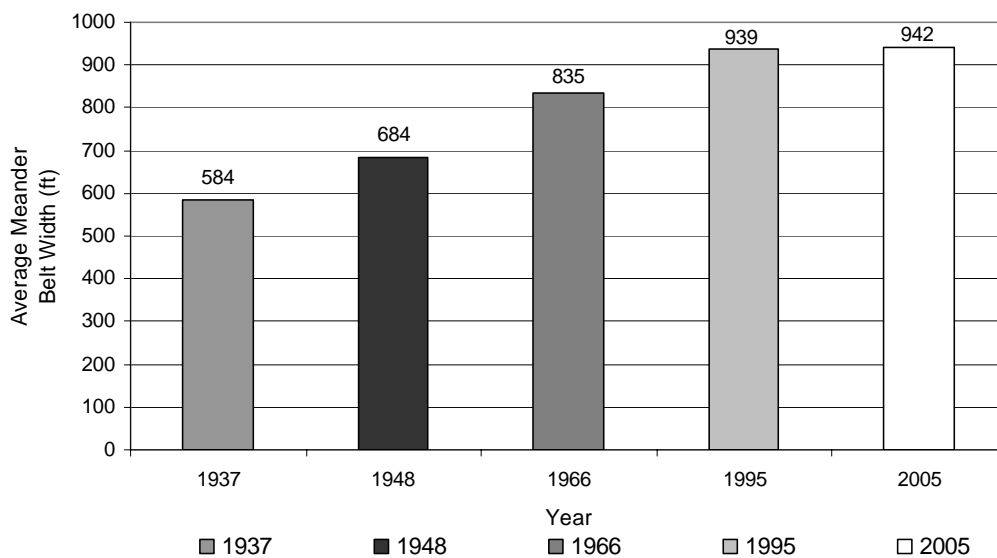
Average meander length in CFR near Clinton, MT for years 1937, 1948, 1966, 1995 and 2005. Results based on air photo interpretation.



Average radius of curvature in CFR near Clinton, MT for years 1937, 1948, 1966, 1995 and 2005. Results based on air photo interpretation.



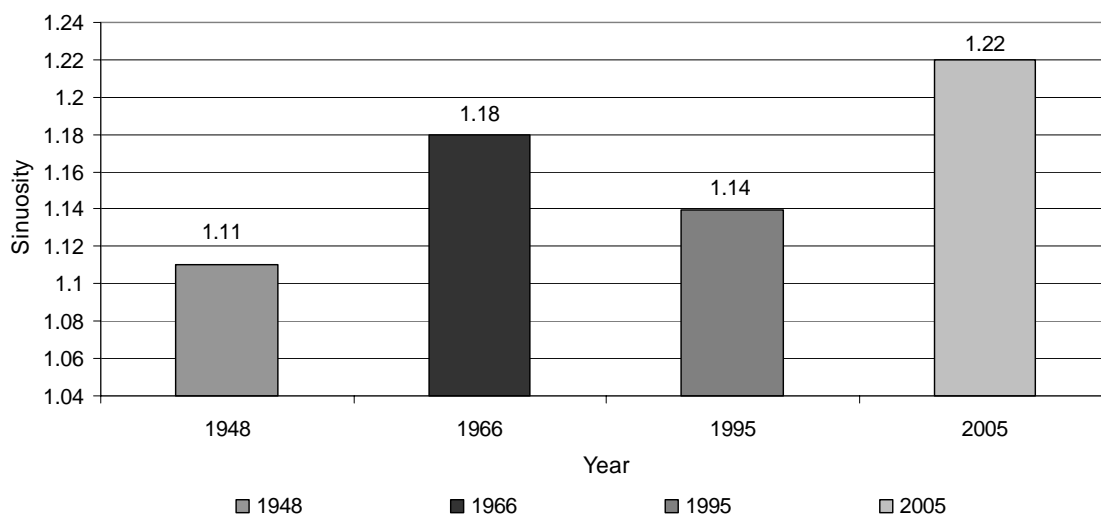
Average meander belt width in CFR near Clinton, MT for years 1937, 1948, 1966, 1995 and 2005. Results based on air photo interpretation.



Summary of channel sinuosity data for CFR near Clinton, MT for years 1948, 1966, 1995 and 2005.

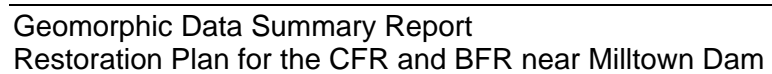
Year	Channel Sinuosity (ft/ft)
1948	1.11
1966	1.18
1995	1.14
2005	1.22

Channel sinuosity values for CFR near Clinton, MT for years 1948, 1966, 1995 and 2005. Results based on air photo interpretation.

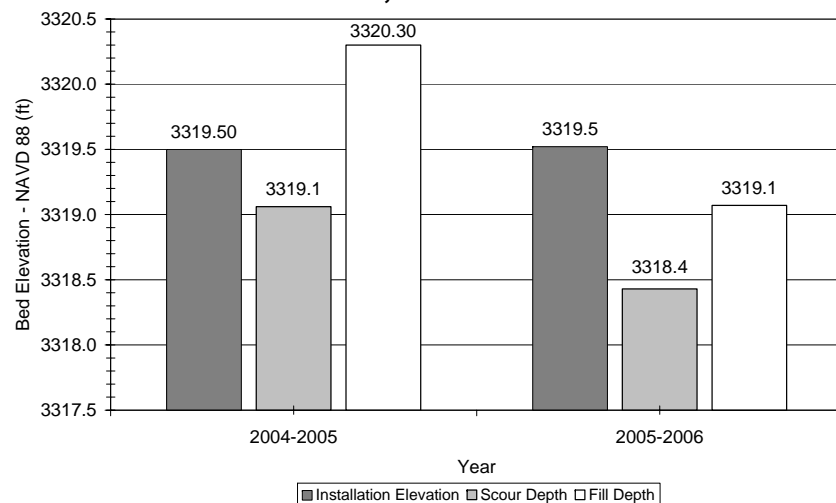


Appendix M

Scour Chains



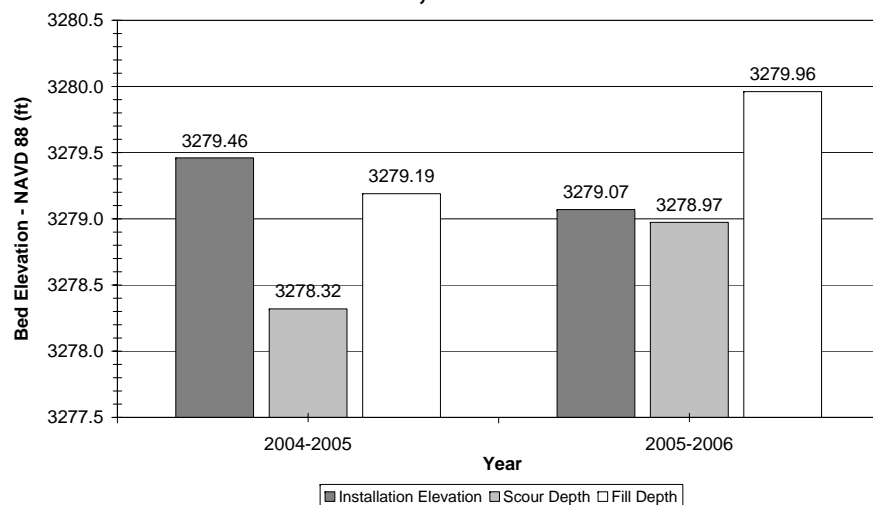
Clark Fork River near Turah, MT Cross-Section 2, Scour Chain 04-T2



XS 2 Riffle						
Year	Install Elev (ft)	Scour Elev (ft)	Fill Elev (ft)	Total Scour (ft)	Total Fill (ft)	Net Bed Elevation Change (ft)
2004-2005	3319.50	3319.06	3320.30	-0.44	1.24	+0.80
2005-2006	3319.52	3318.43	3319.07	-1.09	0.64	-0.45

XS 2 Riffle				
Year	Largest Particle (mm)	Second Largest Particle (mm)	Mean (mm)	Riffle Score
2004-2005	156	113	135	D90
2005-2006	115	94	105	D83

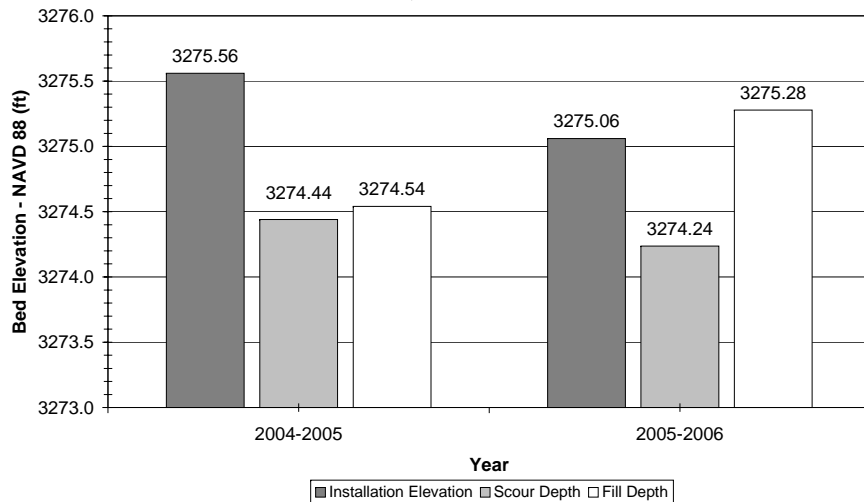
Clark Fork River near Milltown, MT Reach 3B Cross-Section 3, Scour Chain 04-B1



XS 3 Riffle						
Year	Install Elev (ft)	Scour Elev (ft)	Fill Elev (ft)	Total Scour (ft)	Total Fill (ft)	Net Bed Elevation Change (ft)
2004-2005	3279.46	3278.32	3279.19	-1.14	0.87	-0.27
2005-2006	3279.07	3278.97	3279.96	-0.10	0.99	+0.89

XS 3 Riffle				
Year	Largest Particle (mm)	Second Largest Particle (mm)	Mean (mm)	Riffle Score
2004-2005	143	143	143	D80
2005-2006	130	120	125	D70

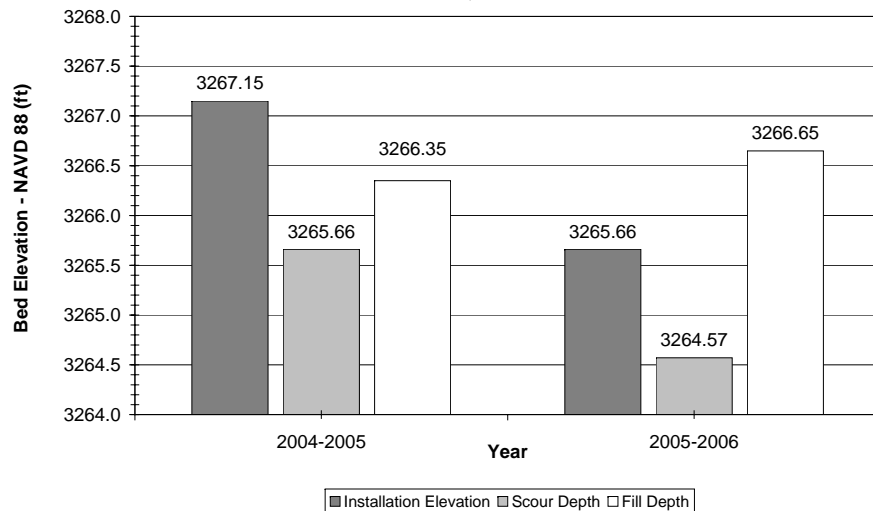
Clark Fork River near Milltown, MT Reach 3B
Cross-Section 9, Scour Chain 04-B2



XS 9 Riffle	Install Elev (ft)	Scour Elev (ft)	Fill Elev (ft)	Total Scour (ft)	Total Fill (ft)	Net Bed Elevation Change (ft)
Year						
2004-2005	3275.56	3274.44	3274.54	-1.12	0.10	-1.02
2005-2006	3275.06	3274.24	3275.28	-0.82	1.04	+0.22

XS 9 Riffle	Largest Particle (mm)	Second Largest Particle (mm)	Mean (mm)	Riffle Score
Year				
2004-2005	113	107	110	D74
2005-2006	170	158	164	D93

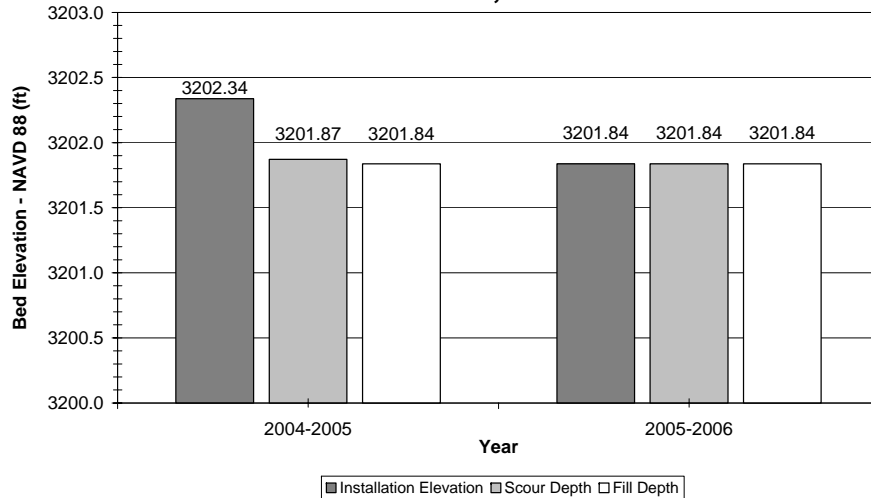
Clark Fork River near Milltown, MT Reach 3B
Cross-Section 19, Scour Chain 04-B3



XS 19 Riffle	Install Elev (ft)	Scour Elev (ft)	Fill Elev (ft)	Total Scour (ft)	Total Fill (ft)	Net Bed Elevation Change (ft)
Year						
2004-2005	3267.15	3265.66	3266.35	-1.49	0.69	-0.80
2005-2006	3265.66	3264.57	3266.65	-1.09	2.08	+0.99

XS 19 Riffle	Largest Particle (mm)	Second Largest Particle (mm)	Mean (mm)	Riffle Score
Year				
2004-2005	137	101	119	D82
2005-2006	140	120	130	D87

Clark Fork River near Missoula, MT Cross-Section 4, Scour Chain 1

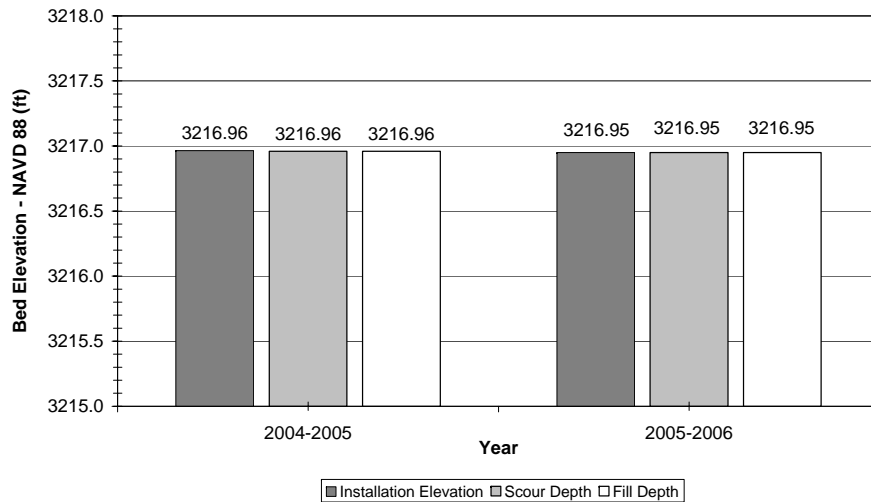


XS 4 Glide	Install Elev (ft)	Scour Elev (ft)	Fill Elev (ft)	Total Scour (ft)	Total Fill (ft)	Net Bed Elevation Change (ft)
Year						
2004-2005	3202.34	3201.87	3201.84	-0.47	-0.03	0.50
2005-2006	3201.84	3201.84	3201.84	0.00	0.00	0

XS 4 Glide	Largest Particle (mm)	Second Largest Particle (mm)	Mean (mm)	Riffle Score
Year				
2004-2005	205	190	198	*D90
2005-2006	205	190	198	*D90

*Interpolated from February 2006 XS 5 Pebble Count

Clark Fork River at Bandman Flats, MT Cross-Section 2, Scour Chain 1

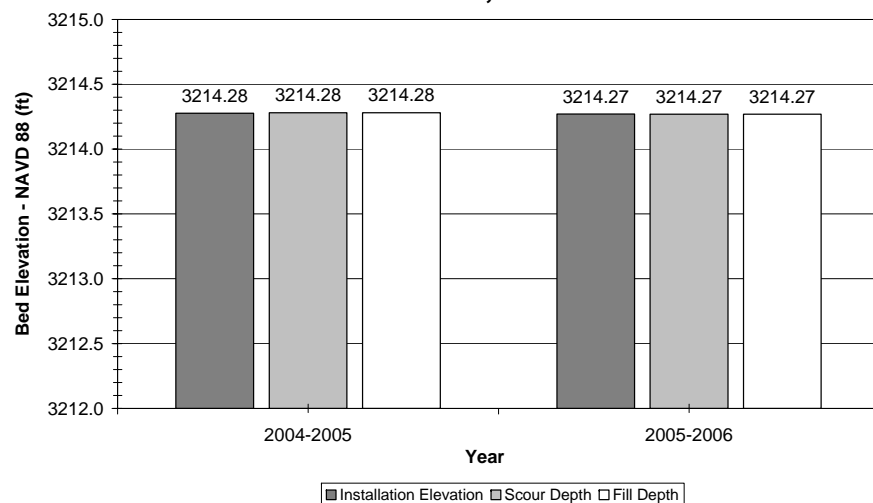


XS 2 Riffle	Install Elev (ft)	Scour Elev (ft)	Fill Elev (ft)	Total Scour (ft)	Total Fill (ft)	Net Bed Elevation Change (ft)
Year						
2004-2005	3216.96	3216.96	3216.96	0	0.00	0
2005-2006	3216.95	3216.95	3216.95	0.00	0.00	0

XS 2 Riffle	Largest Particle (mm)	Second Largest Particle (mm)	Mean (mm)	Riffle Score
Year				
2004-2005	250	200	225	D92
2005-2006	250	200	225	*D92

*Interpolated from February 2006 XS 2 Pebble Count

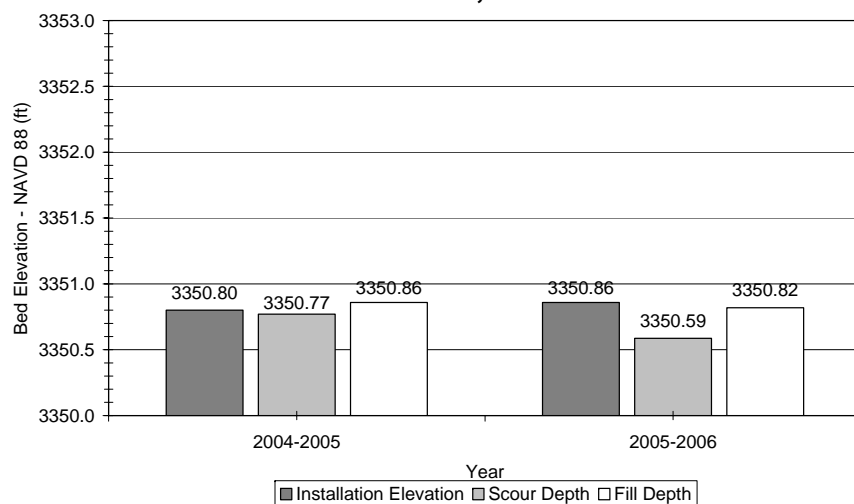
Clark Fork River at Bandman Flats, MT Cross-Section 3, Scour Chain 2



XS 3 Riffle	Install Elev (ft)	Scour Elev (ft)	Fill Elev (ft)	Total Scour (ft)	Total Fill (ft)	Net Bed Elevation Change (ft)
Year						
2004-2005	3214.28	3214.28	3214.28	0	0.00	0.00
2005-2006	3214.27	3214.27	3214.27	0.00	0.00	0.00

XS 3 Riffle	Largest Particle (mm)	Second Largest Particle (mm)	Mean (mm)	Riffle Score
Year				
2004-2005	210	195	203	*D91
2005-2006	210	195	203	*D91

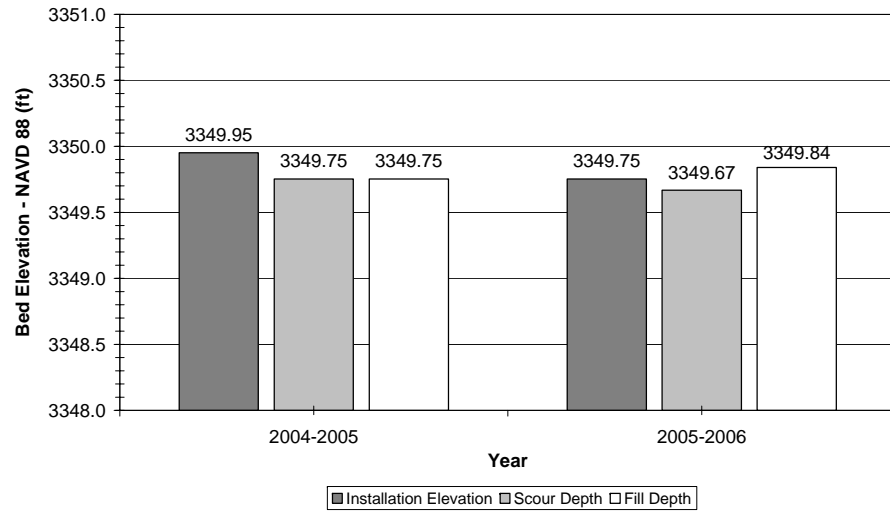
Blackfoot River near Bonner, MT Cross-Section 1, Scour Chain 1



XS 1 Riffle	Install Elev (ft)	Scour Elev (ft)	Fill Elev (ft)	Total Scour (ft)	Total Fill (ft)	Net Bed Elevation Change (ft)
Year						
2004-2005	3350.80	3350.77	3350.86	-0.0306	0.09	-0.06
2005-2006	3350.86	3350.59	3350.82	-0.27	0.23	0.04

XS 1 Riffle	Largest Particle (mm)	Second Largest Particle (mm)	Mean (mm)	Riffle Score
Year				
2004-2005	320	190	255	D83
2005-2006	320	182	251	D82

Blackfoot River near Bonner, MT Cross-Section 1, Scour Chain 2

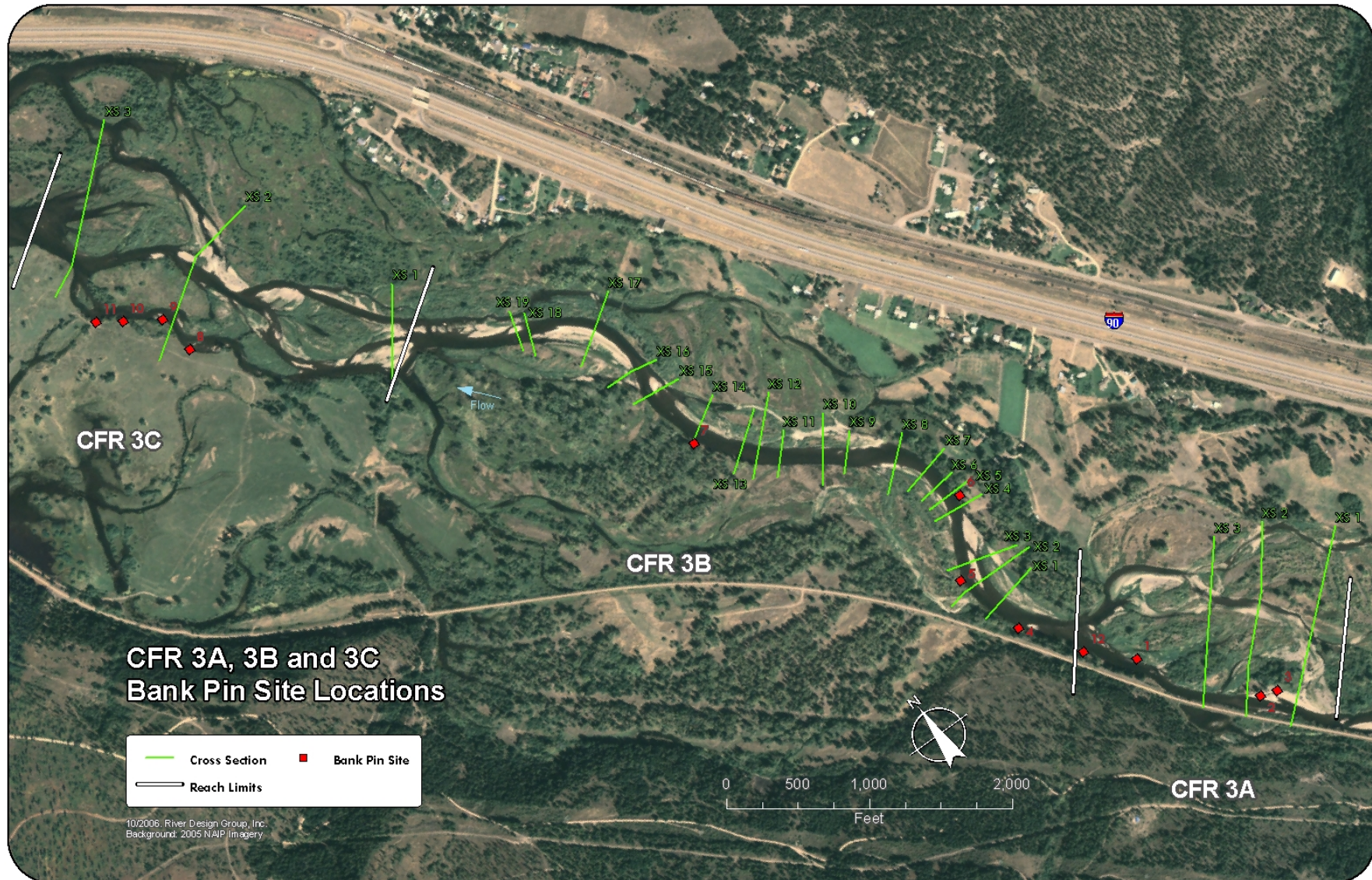


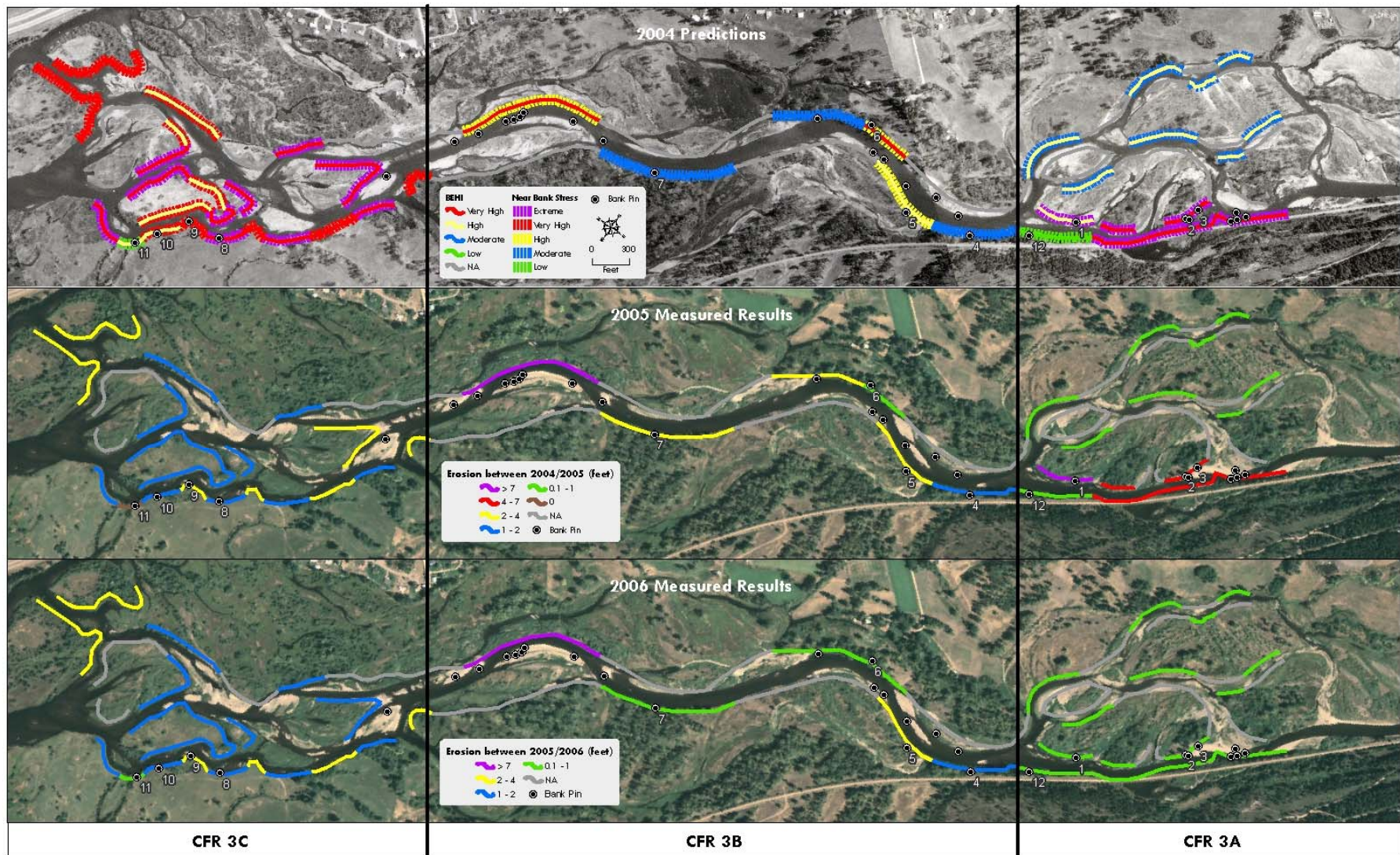
XS 1 Riffle	Install Elev (ft)	Scour Elev (ft)	Fill Elev (ft)	Total Scour (ft)	Total Fill (ft)	Net Bed Elevation Change (ft)
Year						
2004-2005	3349.95	3349.75	3349.75	-0.1995	0.00	0.20
2005-2006	3349.75	3349.67	3349.84	-0.08	0.17	-0.09

XS 1 Riffle	Largest Particle (mm)	Second Largest Particle (mm)	Mean (mm)	Riffle Score
Year				
2004-2005	185	180	183	D53
2005-2006	180	179	180	D52

Appendix N

Bank Erosion Prediction





Bank Erosion Prediction: BEHI and Near Bank Stress (NBS)

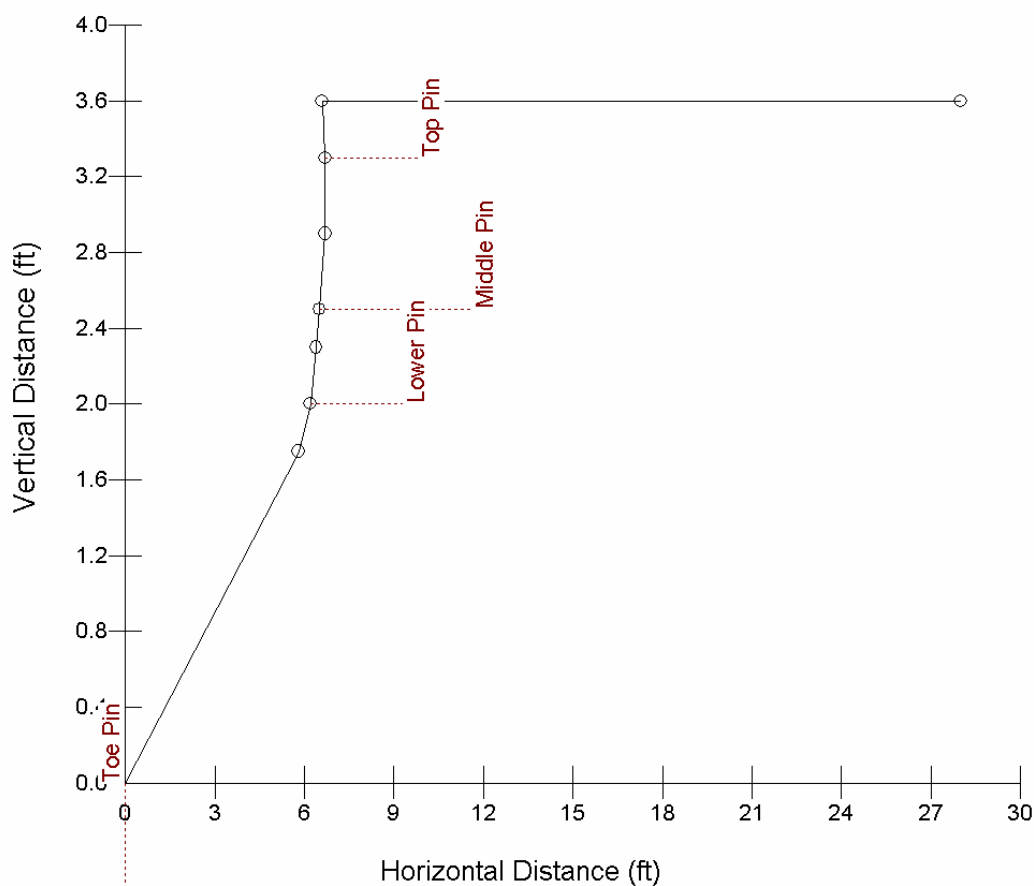
Reach CFR 3A

Predicted and Measured Bank Erosion Summary Table 2004-2005

CFR 3A		Predicted erosion (tons/yr)		Measured	
Site	Bank Length (ft)	Yellowstone Data	Colorado Data	ft/yr	tons/yr
2	1189	572.0	298.0	6.7	1530.0
3	1189	658.0	342.0	4.0	1059.0
1	476	206.0	107.0	15.0	1238.0
12	606	5.5	5.7	0.4	63.7
braids	2027	205.0	87.8	0	0
terraces	1242	251.0	108.0	0	0
Total	6729	1898	949		3891
Percent of Measured		49%	24%		

Predicted and Measured Bank Erosion Summary Table 2005-2006

CFR 3A		Predicted erosion (tons/yr)		Measured	
Site	Bank Length (ft)	Yellowstone Data	Colorado Data	ft/yr	tons/yr
2	1189	469	244.0	0.46	86.4
3	1189	658	342.0	n/a	0.0
1	476	206	107.0	0.50	41.3
12	606	5	5.6	0.24	39.1
braids	2027	205	87.8	0	0.0
terraces	1242	251	108.0	0	0.0
Total	6729	1795	894.35		167
Percent of Measured		1076%	536%		

Site: 1**Erodability Rating: High****Near Bank Stress: Extreme**

2004 bank profile of Site 1 in CFR 3A.

Site 1 Measured Bank Erosion (in ft)			
Distance from toe pin (ft)	2004	2005	2006
Top of Bank	6.6	38.0 ¹	0.0
Top Pin	6.7	38.0	0.0
Middle Pin	6.5	38.0	0.0
Lower Pin	6.2	38.0	0.0
Toe of Bank	5.8	38.0	0.0

¹ Bank pins eroded in spring 2005. Values estimated from sag tape measurement and channel cross-sections.

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 A
BEHI Name: Bankpin Site 1
Survey Date: 09/13/06

Bankfull Height: 3.6 ft
Bank Height: 3.6 ft
Root Depth: 1 ft
Root Density: 45 %
Bank Angle: 90 Degrees
Surface Protection: 45 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #6: Near-Bank Shear Stress

Mean Depth: 6.06 ft	Average Slope: 0.004 ft/ft
NB Max Depth: 7.74 ft	NB Slope: 0.012 ft/ft
Shear Stress: 1.51 lb/sq/ft	NB Shear Stress: 5.80 lb/sq/ft
Stress Ratio: 3.83	

BEHI Numerical Rating: 32.9
BEHI Adjective Rating: High
NBS Numerical Rating: 3.83
NBS Adjective Rating: Extreme
Total Bank Length: 476 ft
Estimated Sediment Loss: 31.73 Cu Yds per Year
Estimated Sediment Loss: 41.25 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 A
BEHI Name: Bankpin Site 1
Survey Date: 09/13/06

Bankfull Height: 3.6 ft
Bank Height: 3.6 ft
Root Depth: 1 ft
Root Density: 45 %
Bank Angle: 90 Degrees
Surface Protection: 45 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Colorado

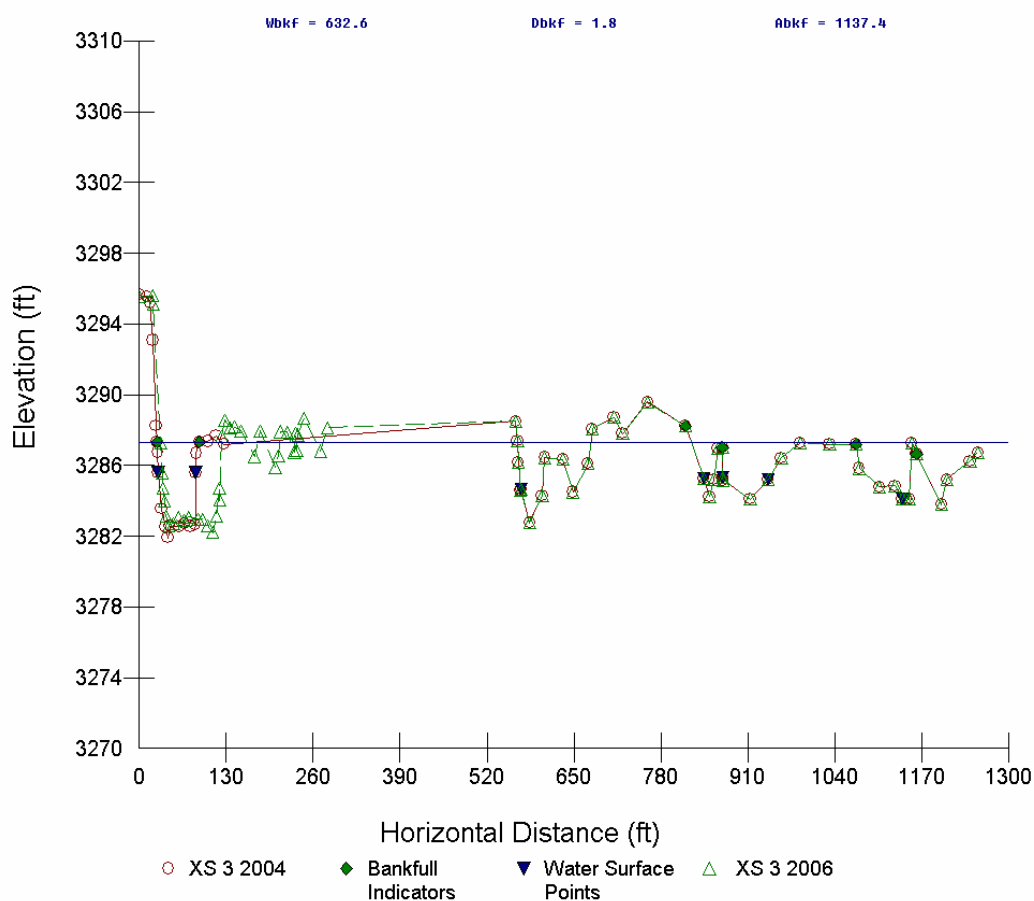
NBS Method #6: Near-Bank Shear Stress

Mean Depth: 6.06 ft	Average Slope: 0.004 ft/ft
NB Max Depth: 7.74 ft	NB Slope: 0.012 ft/ft
Shear Stress: 1.51 lb/sq/ft	NB Shear Stress: 5.80 lb/sq/ft
Stress Ratio: 3.83	

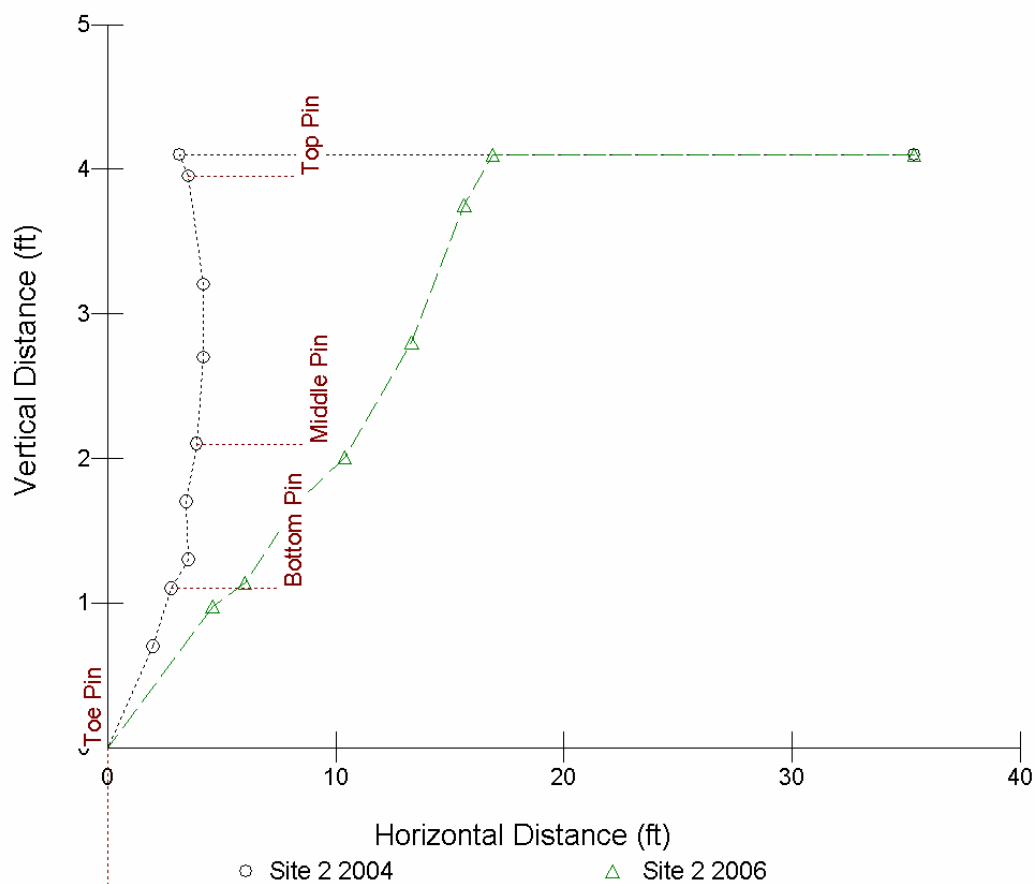
BEHI Numerical Rating: 32.9
BEHI Adjective Rating: High
NBS Numerical Rating: 3.83
NBS Adjective Rating: Extreme
Total Bank Length: 476 ft
Estimated Sediment Loss: 82.51 Cu Yds per Year
Estimated Sediment Loss: 107.26 Tons per Year



Site 1 in 2004 (left) and 2006 (right).



Cross-section 3 in the vicinity of Site 1 (2004 and 2006 surveys).

Site: **2**Erodability Rating: **Very High** Near Bank Stress: **Extreme**

Site 2 Measured Bank Erosion (in ft)						
Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	3.2	13.7	16.9	10.6	3.2	13.7
Top Pin	3.6	13.6	15.6	10.1	2.0	12.1
Middle Pin	3.9	10.5	10.6	6.6	0.1	6.7
Lower Pin	2.8	9.1	6.0	6.3	-3.1	3.2
Toe of Bank	2.0	2.0	2.0	-0.1	0.1	0.0
Average Change				6.7	0.5	7.1

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 A
BEHI Name: Bankpin Site 2
Survey Date: 09/13/06

Bankfull Height: 4 ft
Bank Height: 4 ft
Root Depth: 0.5 ft
Root Density: 5 %
Bank Angle: 90 Degrees
Surface Protection: 7.5 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #2: Ratio of Radius of Curvature to Bankfull Width

Radius of Curvature: 132 ft Bankfull Width: 137 ft
Ratio: 0.96 psf

BEHI Numerical Rating: 42.0
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0.96
NBS Adjective Rating: Extreme
Total Bank Length: 1189 ft
Estimated Sediment Loss: 1176.67 Cu Yds per Year
Estimated Sediment Loss: 1529.67 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 A
BEHI Name: Bankpin Site 2
Survey Date: 09/13/06

Bankfull Height: 4 ft
Bank Height: 4 ft
Root Depth: 0.5 ft
Root Density: 5 %
Bank Angle: 90 Degrees
Surface Protection: 7.5 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Colorado

NBS Method #2: Ratio of Radius of Curvature to Bankfull Width

Radius of Curvature: 132 ft Bankfull Width: 137 ft
Ratio: 0.96 psf

BEHI Numerical Rating: 42.0
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0.96
NBS Adjective Rating: Extreme
Total Bank Length: 1189 ft
Estimated Sediment Loss: 228.99 Cu Yds per Year
Estimated Sediment Loss: 297.69 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3A
BEHI Name: Site 2 2006
Survey Date: 08/22/06

Bankfull Height: 2.3 ft
Bank Height: 3.28 ft
Root Depth: 0.3 ft
Root Density: 2.5 %
Bank Angle: 45 Degrees
Surface Protection: 5 %

Bank Material Adjustment: Gravel 2

Bank Stratification Adjustment: Yes 5

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Extreme

BEHI Numerical Rating: 44.2
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: Extreme
Total Bank Length: 1189 ft
Estimated Sediment Loss: 66.44 Cu Yds per Year
Estimated Sediment Loss: 86.37 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3A
BEHI Name: Site 2 2006
Survey Date: 08/22/06

Bankfull Height: 2.3 ft
Bank Height: 3.28 ft
Root Depth: 0.3 ft
Root Density: 2.5 %
Bank Angle: 45 Degrees
Surface Protection: 5 %

Bank Material Adjustment: Gravel 2

Bank Stratification Adjustment: Yes 5

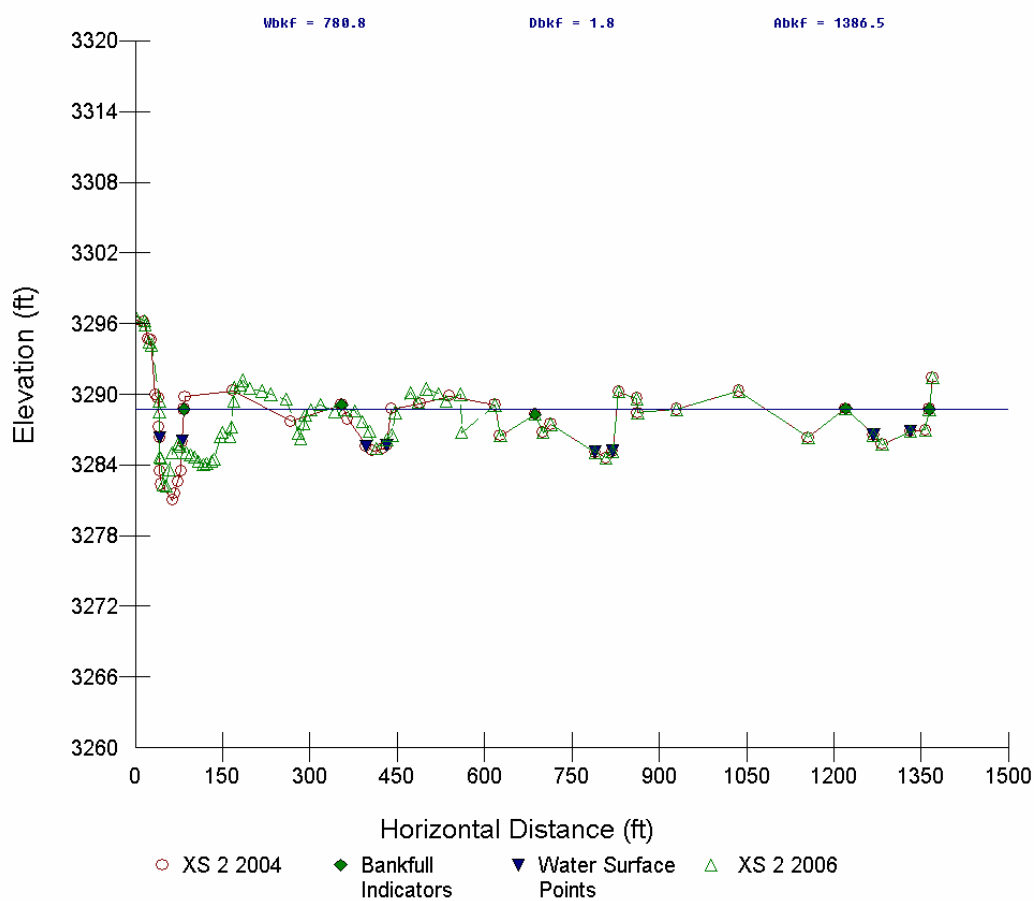
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Extreme

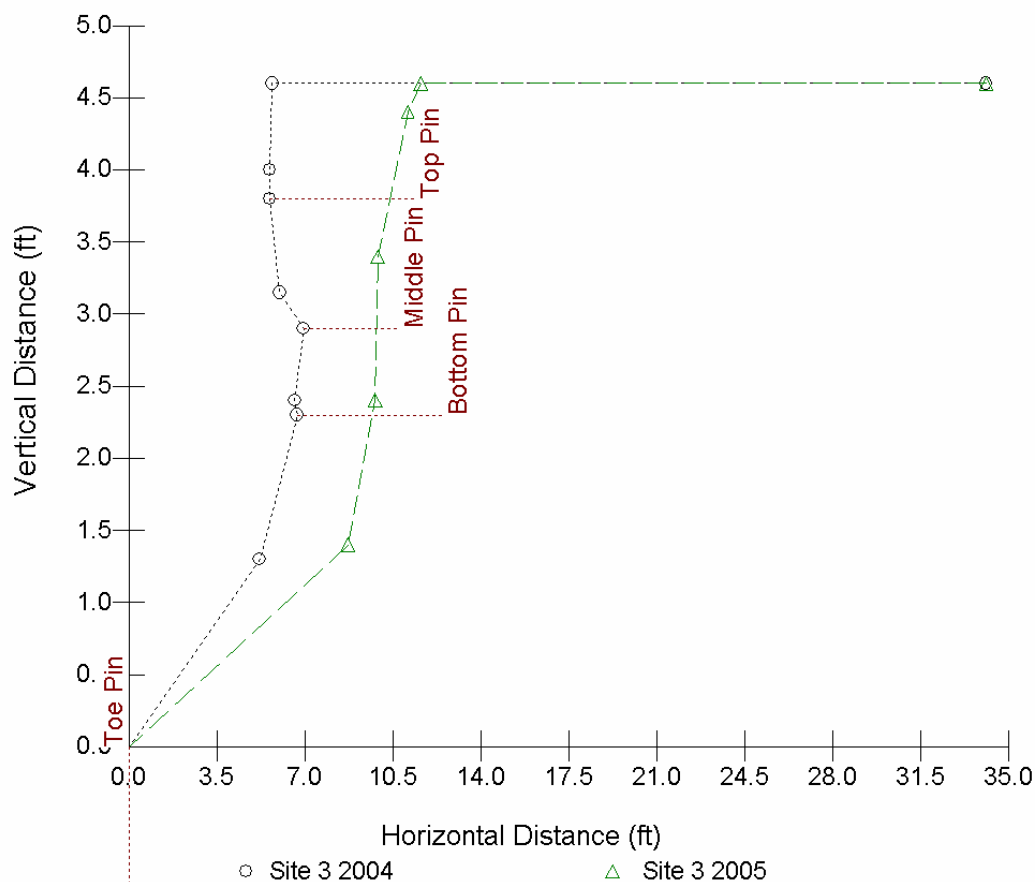
BEHI Numerical Rating: 44.2
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: Extreme
Total Bank Length: 1189 ft
Estimated Sediment Loss: 187.77 Cu Yds per Year
Estimated Sediment Loss: 244.1 Tons per Year



Site 2 in 2004 (left) and 2006 (right).



Cross-section 2 in the vicinity of Site 2 (2004 and 2006 surveys).

Site: 3**Erodability Rating: Very High Near Bank Stress: Extreme****Site 3 Measured Bank Erosion (in ft)**

Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	5.7	11.6	site buried	5.90		
Top Pin	5.6	10.3	buried	4.7		
Middle Pin	7.0	9.9		2.9		
Lower Pin	6.7	9.8		3.1		
Toe of Bank	5.2	8.7		3.5		
Average Change				4.0		

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 A
BEHI Name: Bankpin Site 3
Survey Date: 09/13/06

Bankfull Height: 4 ft
Bank Height: 4.6 ft
Root Depth: 0.5 ft
Root Density: 15 %
Bank Angle: 100 Degrees
Surface Protection: 15 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #2: Ratio of Radius of Curvature to Bankfull Width

Radius of Curvature: 132 ft Bankfull Width: 137 ft
Ratio: 0.96 psf

BEHI Numerical Rating: 42.5
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0.96
NBS Adjective Rating: Extreme
Total Bank Length: 1189 ft
Estimated Sediment Loss: 506.43 Cu Yds per Year
Estimated Sediment Loss: 658.36 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 A
BEHI Name: Bankpin Site 3
Survey Date: 09/13/06

Bankfull Height: 4 ft
Bank Height: 4.6 ft
Root Depth: 0.5 ft
Root Density: 15 %
Bank Angle: 100 Degrees
Surface Protection: 15 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Colorado

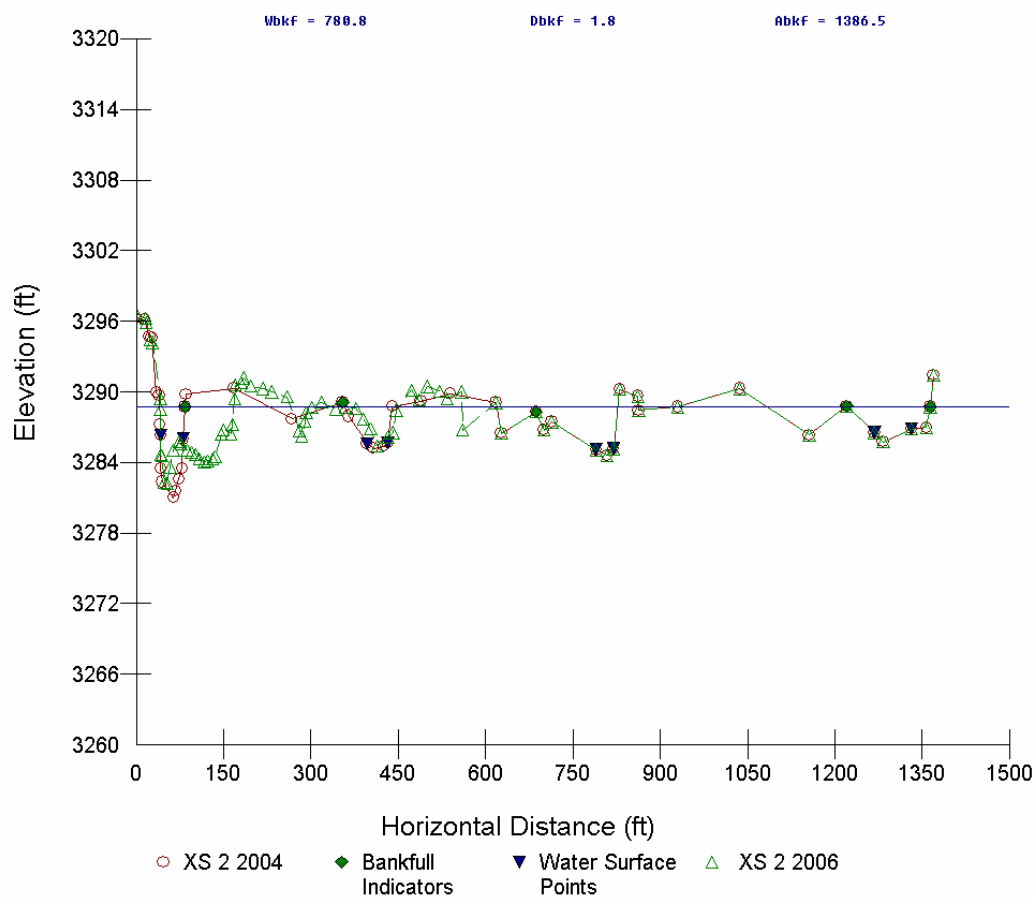
NBS Method #2: Ratio of Radius of Curvature to Bankfull Width

Radius of Curvature: 132 ft Bankfull Width: 137 ft
Ratio: 0.96 psf

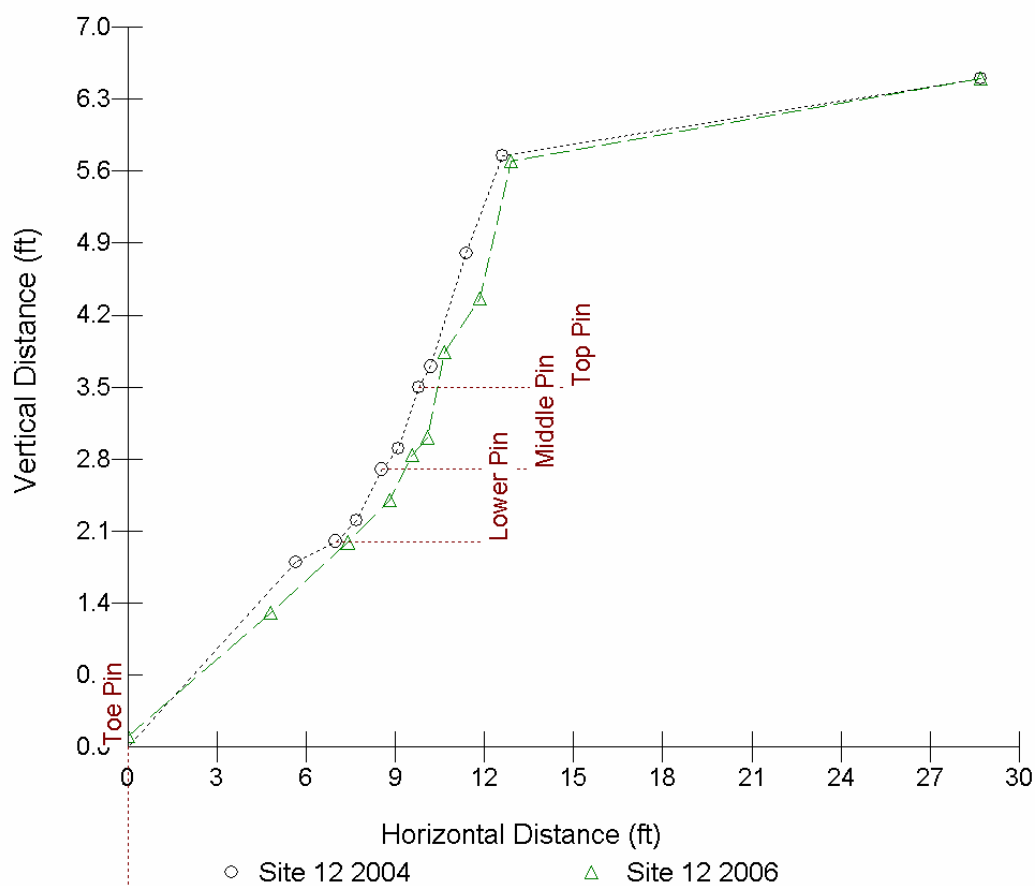
BEHI Numerical Rating: 42.5
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0.96
NBS Adjective Rating: Extreme
Total Bank Length: 1189 ft
Estimated Sediment Loss: 263.34 Cu Yds per Year
Estimated Sediment Loss: 342.34 Tons per Year



Site 3 in 2004 (left) and 2005 (right).



Cross-section 2 in the vicinity of Site 3 (2004 and 2006 surveys).

Site: **12**Erodability Rating: **Low**Near Bank Stress: **Low**

2004 and 2006 bank profiles at Site 12 in CFR 3A.

Site 12 Measured Bank Erosion (in ft)						
Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	12.6	12.6	12.9	0.0	0.3	0.3
Top Pin	9.8	10.0	10.5	0.2	0.5	0.7
Middle Pin	8.6	9.0	9.40	0.4	0.4	0.9
Lower Pin	7.0	7.5	7.5	0.5	0.0	0.5
Toe of Bank	5.7	6.4	6.4	0.7	0.0	0.8
Average Change				0.3	0.3	0.6

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 A
BEHI Name: Bankpin Site 12
Survey Date: 09/13/06

Bankfull Height: 3.75 ft
Bank Height: 5.75 ft
Root Depth: 1.5 ft
Root Density: 50 %
Bank Angle: 40 Degrees
Surface Protection: 55 %

Bank Material Adjustment: Cobble -10

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #5: Ratio of Near-Bank Maximum Bankfull Depth to
Mean Bankfull Depth

NB Max Depth: 5.4 ft Mean Depth: 4.08 ft
Ratio: 1.32

BEHI Numerical Rating: 17.0
BEHI Adjective Rating: Low
NBS Numerical Rating: 1.32
NBS Adjective Rating: Low
Total Bank Length: 606 ft
Estimated Sediment Loss: 4.26 Cu Yds per Year
Estimated Sediment Loss: 5.54 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 A
BEHI Name: Bankpin Site 12
Survey Date: 09/13/06

Bankfull Height: 3.75 ft
Bank Height: 5.75 ft
Root Depth: 1.5 ft
Root Density: 50 %
Bank Angle: 40 Degrees
Surface Protection: 55 %

Bank Material Adjustment: Cobble -10

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Colorado

NBS Method #5: Ratio of Near-Bank Maximum Bankfull Depth to
Mean Bankfull Depth

NB Max Depth: 5.4 ft Mean Depth: 4.08 ft
Ratio: 1.32

BEHI Numerical Rating: 17.0
BEHI Adjective Rating: Low
NBS Numerical Rating: 1.32
NBS Adjective Rating: Low
Total Bank Length: 606 ft
Estimated Sediment Loss: 4.39 Cu Yds per Year
Estimated Sediment Loss: 5.71 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3A
BEHI Name: Site 12 2006
Survey Date: 08/22/06

Bankfull Height: 4.35 ft
Bank Height: 5.59 ft
Root Depth: 2 ft
Root Density: 20 %
Bank Angle: 50 Degrees
Surface Protection: 20 %

Bank Material Adjustment: Cobble -10

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Low

BEHI Numerical Rating: 19.3
BEHI Adjective Rating: Low
NBS Numerical Rating: 0
NBS Adjective Rating: Low
Total Bank Length: 606 ft
Estimated Sediment Loss: 30.11 Cu Yds per Year
Estimated Sediment Loss: 39.14 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3A
BEHI Name: Site 12 2006
Survey Date: 08/22/06

Bankfull Height: 4.35 ft
Bank Height: 5.59 ft
Root Depth: 2 ft
Root Density: 20 %
Bank Angle: 50 Degrees
Surface Protection: 20 %

Bank Material Adjustment: Cobble -10

Bank Stratification Adjustment: None 0

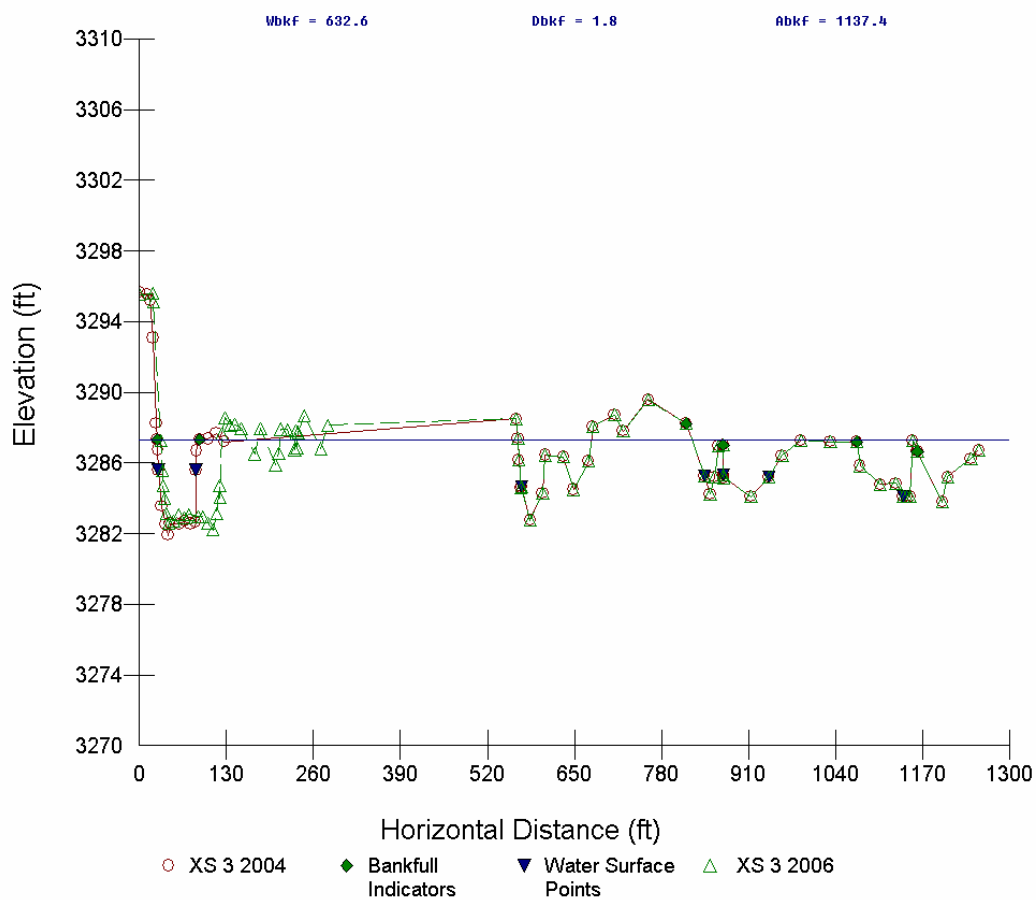
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Low

BEHI Numerical Rating: 19.3
BEHI Adjective Rating: Low
NBS Numerical Rating: 0
NBS Adjective Rating: Low
Total Bank Length: 606 ft
Estimated Sediment Loss: 4.27 Cu Yds per Year
Estimated Sediment Loss: 5.55 Tons per Year



Site 12 in 2004 (left) and 2006 (right).



Cross-section 3 in the vicinity of Site 12 (2004 and 2006 surveys).

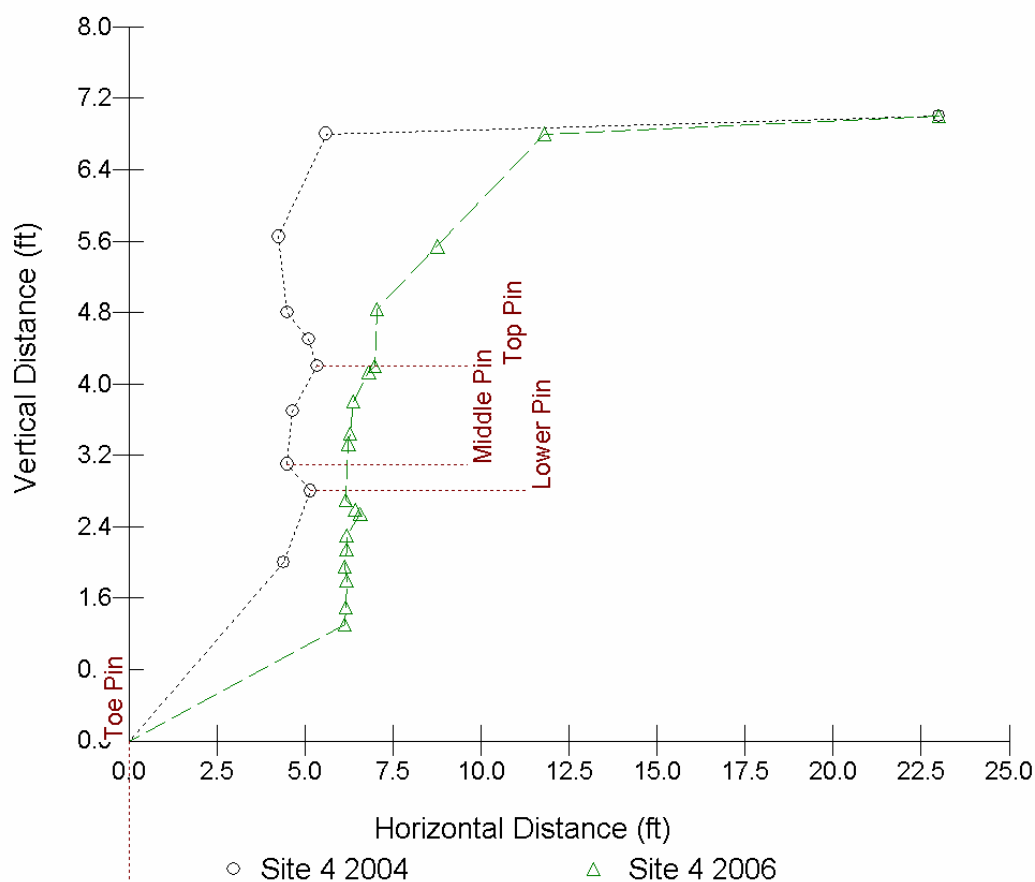
Reach CFR 3B Reference

Predicted and Measured Bank Erosion Summary Table 2004-2005

CFR 3B		Predicted erosion (tons/yr)		Measured	
Site	Bank Length (ft)	Yellowstone Data	Colorado Data	ft/yr	tons/yr
4	658	73	41	1.15	248
5	695	141	59	3.87	453
6	561	208	87	0.45	78
7	1973	216	121	3.31	2107
XS 17	1074	776	403	8.00	2482
Total	4961	1414	710		5368
Percent of Measured		26.0	13.0		

Predicted and Measured Bank Erosion Summary Table Bank Erosion 2005-2006

CFR 3B		Predicted erosion (tons/yr)		Measured	
Site	Bank Length (ft)	Yellowstone Data	Colorado Data	ft/yr	tons/yr
4	658	48.5	27	1.31	187
5	695	145	60	3.70	446
6	561	163	68	0.56	76
7	1973	142	79	0.83	347
XS 17	1074	387	182	8.00	1820
Total	4961	886	416		2876
Percent of Measured		31	14		

Site: 4**Erodability Rating: Moderate Near Bank Stress: Moderate**

2004 and 2006 bank profiles at Site 4 in CFR 3B.

Site 4 Measured Bank Erosion (in ft)						
Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	5.6	11.8	11.8	6.2	0.0	6.2
Top Pin	5.4	5.1	7.0	-0.3	1.9	1.6
Middle Pin	4.5	4.7	6.2	0.2	1.5	1.7
Lower Pin	5.2	4.8	6.2	-0.4	1.4	1.0
Toe of Bank	4.4	4.4	6.1	0.0	1.7	1.7
Average Change				1.2	1.3	2.5

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 B Reference
BEHI Name: Bankpin Site 4
Survey Date: 09/13/06

Bankfull Height: 4.5 ft
Bank Height: 6.8 ft
Root Depth: 3 ft
Root Density: 55 %
Bank Angle: 100 Degrees
Surface Protection: 55 %

Bank Material Adjustment: Gravel 0

Bank Stratification Adjustment: Yes 1

Erosion Loss Curve: Yellowstone

NBS Method #5: Ratio of Near-Bank Maximum Bankfull Depth to
Mean Bankfull Depth

NB Max Depth: 7.85 ft Mean Depth: 4.73 ft
Ratio: 1.66

BEHI Numerical Rating: 29.9
BEHI Adjective Rating: Moderate
NBS Numerical Rating: 1.66
NBS Adjective Rating: Moderate
Total Bank Length: 658 ft
Estimated Sediment Loss: 56.34 Cu Yds per Year
Estimated Sediment Loss: 73.24 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 B Reference
BEHI Name: Bankpin Site 4
Survey Date: 09/13/06

Bankfull Height: 4.5 ft
Bank Height: 6.8 ft
Root Depth: 3 ft
Root Density: 55 %
Bank Angle: 100 Degrees
Surface Protection: 55 %

Bank Material Adjustment: Gravel 0

Bank Stratification Adjustment: Yes 1

Erosion Loss Curve: Colorado

NBS Method #5: Ratio of Near-Bank Maximum Bankfull Depth to
Mean Bankfull Depth

NB Max Depth: 7.85 ft Mean Depth: 4.73 ft
Ratio: 1.66

BEHI Numerical Rating: 29.9
BEHI Adjective Rating: Moderate
NBS Numerical Rating: 1.66
NBS Adjective Rating: Moderate
Total Bank Length: 658 ft
Estimated Sediment Loss: 31.49 Cu Yds per Year
Estimated Sediment Loss: 40.94 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3B
BEHI Name: Site 4 2006
Survey Date: 08/23/06

Bankfull Height: 3.9 ft
Bank Height: 4.5 ft
Root Depth: 2.3 ft
Root Density: 75 %
Bank Angle: 112 Degrees
Surface Protection: 40 %

Bank Material Adjustment: Gravel 0

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Moderate

BEHI Numerical Rating: 25.9
BEHI Adjective Rating: Moderate
NBS Numerical Rating: 0
NBS Adjective Rating: Moderate
Total Bank Length: 658 ft
Estimated Sediment Loss: 143.66 Cu Yds per Year
Estimated Sediment Loss: 186.76 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3B
BEHI Name: Site 4 2006
Survey Date: 08/23/06

Bankfull Height: 3.9 ft
Bank Height: 4.5 ft
Root Depth: 2.3 ft
Root Density: 75 %
Bank Angle: 112 Degrees
Surface Protection: 40 %

Bank Material Adjustment: Gravel 0

Bank Stratification Adjustment: None 0

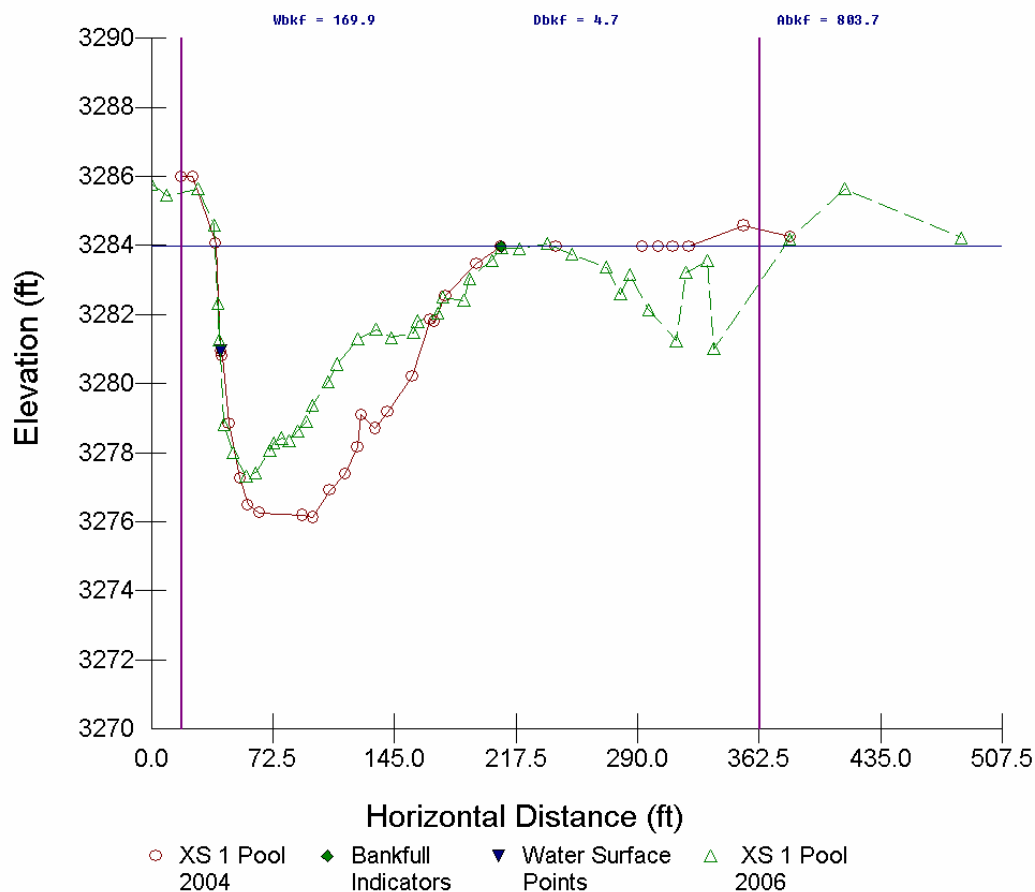
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Moderate

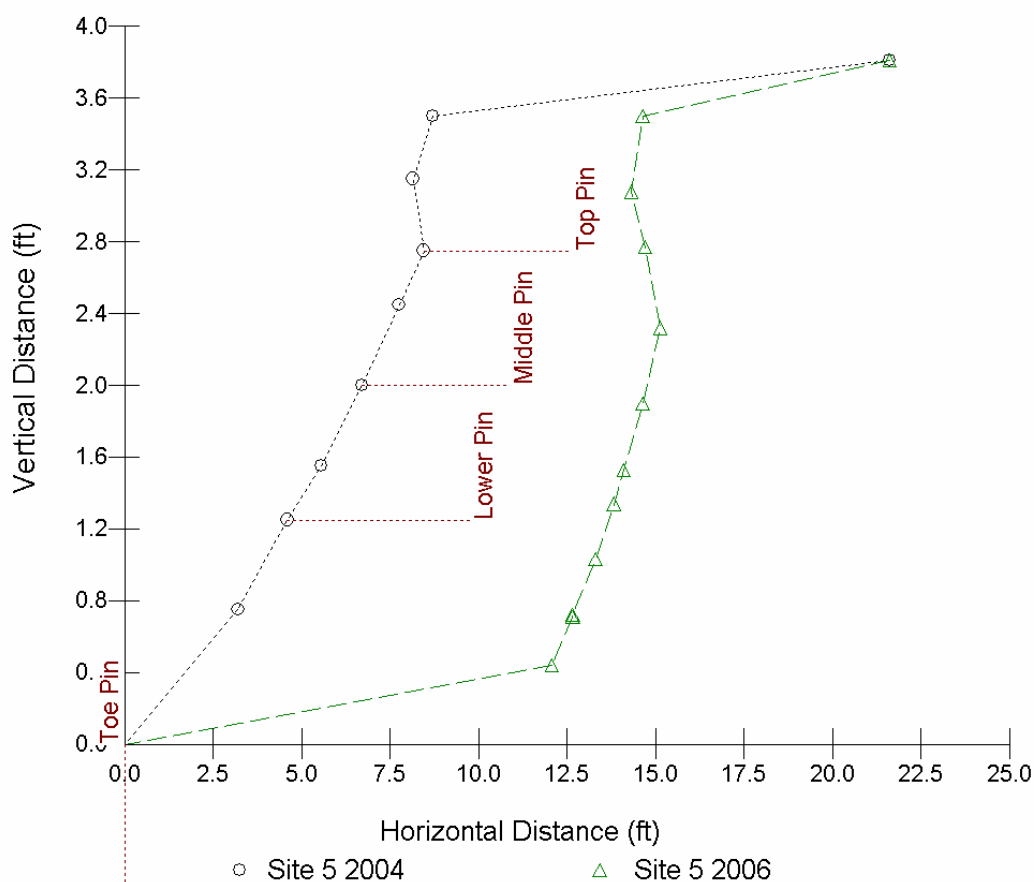
BEHI Numerical Rating: 25.9
BEHI Adjective Rating: Moderate
NBS Numerical Rating: 0
NBS Adjective Rating: Moderate
Total Bank Length: 658 ft
Estimated Sediment Loss: 20.84 Cu Yds per Year
Estimated Sediment Loss: 27.09 Tons per Year



Site 4 in 2004 (left) and 2006 (right).



Cross-section 1 in the vicinity of Site 4 (2004 and 2006 surveys).

Site: 5**Erodability Rating: High****Near Bank Stress: High**

2004 and 2006 bank profiles at Site 5 in CFR 3B.

Site 5 Measured Bank Erosion (in ft)						
Dist fm toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	8.7	11.3	14.6	2.6	3.3	5.9
Top Pin	8.5	10.5	14.7	2.1	4.2	6.3
Middle Pin	6.7	10.4	14.6	3.7	4.2	7.9
Lower Pin	4.6	9.7	13.5	5.1	3.8	8.9
Toe of Bank	3.2	9.1	12.1	5.9	3.0	8.9
Average Change				5.9	3.0	8.9

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 B Reference
BEHI Name: Bankpin Site 5
Survey Date: 09/13/06

Bankfull Height: 3.5 ft
Bank Height: 3.5 ft
Root Depth: 0.5 ft
Root Density: 20 %
Bank Angle: 45 Degrees
Surface Protection: 25 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: High

BEHI Numerical Rating: 33.7
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: High
Total Bank Length: 695 ft
Estimated Sediment Loss: 108.11 Cu Yds per Year
Estimated Sediment Loss: 140.54 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 B Reference
BEHI Name: Bankpin Site 5
Survey Date: 09/13/06

Bankfull Height: 3.5 ft
Bank Height: 3.5 ft
Root Depth: 0.5 ft
Root Density: 20 %
Bank Angle: 45 Degrees
Surface Protection: 25 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: High

BEHI Numerical Rating: 33.7
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: High
Total Bank Length: 695 ft
Estimated Sediment Loss: 45.05 Cu Yds per Year
Estimated Sediment Loss: 58.57 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3B
BEHI Name: Site 5 2006
Survey Date: 08/23/06

Bankfull Height: 3.2 ft
Bank Height: 3.6 ft
Root Depth: 1 ft
Root Density: 70 %
Bank Angle: 50 Degrees
Surface Protection: 20 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: Yes 5

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: High

BEHI Numerical Rating: 36.5
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: High
Total Bank Length: 695 ft
Estimated Sediment Loss: 342.87 Cu Yds per Year
Estimated Sediment Loss: 445.73 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3B
BEHI Name: Site 5 2006
Survey Date: 08/23/06

Bankfull Height: 3.2 ft
Bank Height: 3.6 ft
Root Depth: 1 ft
Root Density: 70 %
Bank Angle: 50 Degrees
Surface Protection: 20 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: Yes 5

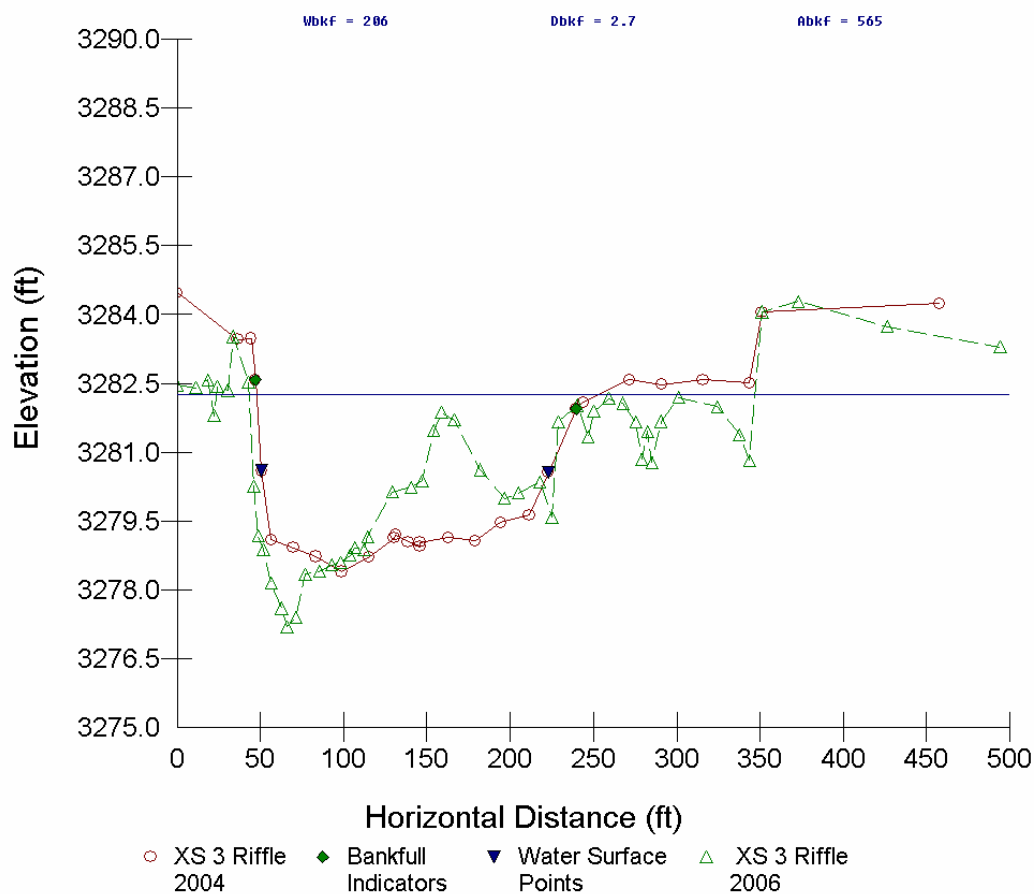
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: High

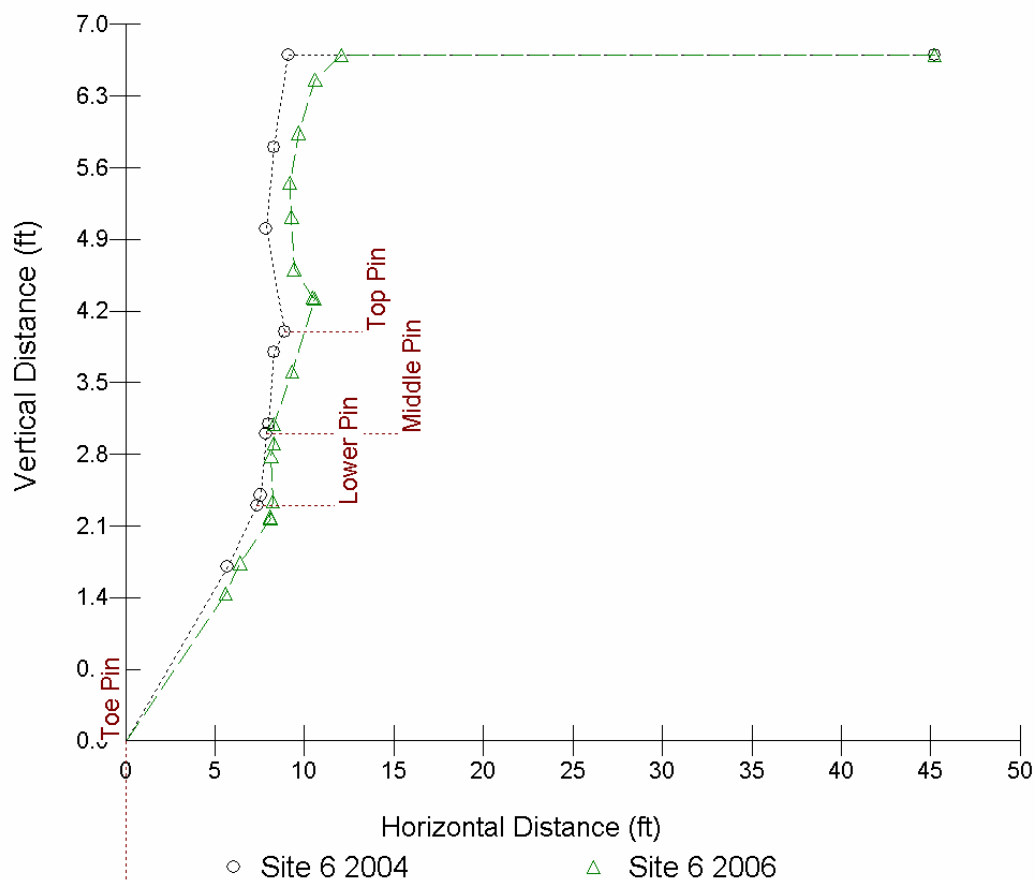
BEHI Numerical Rating: 36.5
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: High
Total Bank Length: 695 ft
Estimated Sediment Loss: 46.33 Cu Yds per Year
Estimated Sediment Loss: 60.23 Tons per Year



Site 5 in 2004 (left) and 2006 (right).



Cross-section 3 in the vicinity of Site 5 (2004 and 2006 surveys).

Site: 6**Erodability Rating: Very High Near Bank Stress: High**

2004 and 2006 bank profiles at Site 6 in CFR 3B.

Site 6 Measured Bank Erosion (in ft)						
Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	9.1	9.7	10.6	0.6	0.9	1.5
Top Pin	8.9	8.4	9.4	-0.5	1.0	0.5
Middle Pin	7.7	7.9	8.1	0.2	0.3	0.5
Lower Pin	7.4	7.2	7.7	-0.2	0.5	0.4
Toe of Bank	5.7	6.3	6.4	0.6	0.1	0.7
Average Change				0.2	0.6	0.7

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 B Reference
BEHI Name: Bankpin Site 6
Survey Date: 09/13/06

Bankfull Height: 5.2 ft
Bank Height: 6.43 ft
Root Depth: 1 ft
Root Density: 7 %
Bank Angle: 90 Degrees
Surface Protection: 11 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #5: Ratio of Near-Bank Maximum Bankfull Depth to
Mean Bankfull Depth

NB Max Depth: 7.82 ft Mean Depth: 3.59 ft
Ratio: 2.18

BEHI Numerical Rating: 43.7
BEHI Adjective Rating: Very High
NBS Numerical Rating: 2.18
NBS Adjective Rating: High
Total Bank Length: 561 ft
Estimated Sediment Loss: 60.12 Cu Yds per Year
Estimated Sediment Loss: 78.16 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 B Reference
BEHI Name: Bankpin Site 6
Survey Date: 09/13/06

Bankfull Height: 5.2 ft
Bank Height: 6.43 ft
Root Depth: 1 ft
Root Density: 7 %
Bank Angle: 90 Degrees
Surface Protection: 11 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Colorado

NBS Method #5: Ratio of Near-Bank Maximum Bankfull Depth to
Mean Bankfull Depth

NB Max Depth: 7.82 ft Mean Depth: 3.59 ft
Ratio: 2.18

BEHI Numerical Rating: 43.7
BEHI Adjective Rating: Very High
NBS Numerical Rating: 2.18
NBS Adjective Rating: High
Total Bank Length: 561 ft
Estimated Sediment Loss: 66.8 Cu Yds per Year
Estimated Sediment Loss: 86.84 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3B
BEHI Name: Site 6 2006
Survey Date: 08/23/06

Bankfull Height: 2.9 ft
Bank Height: 5.02 ft
Root Depth: 3 ft
Root Density: 20 %
Bank Angle: 90 Degrees
Surface Protection: 30 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: Yes 5

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: High

BEHI Numerical Rating: 42.1
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: High
Total Bank Length: 561 ft
Estimated Sediment Loss: 58.41 Cu Yds per Year
Estimated Sediment Loss: 75.93 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3B
BEHI Name: Site 6 2006
Survey Date: 08/23/06

Bankfull Height: 2.9 ft
Bank Height: 5.02 ft
Root Depth: 3 ft
Root Density: 20 %
Bank Angle: 90 Degrees
Surface Protection: 30 %

Bank Material Adjustment: Gravel 5

Bank Stratification Adjustment: Yes 5

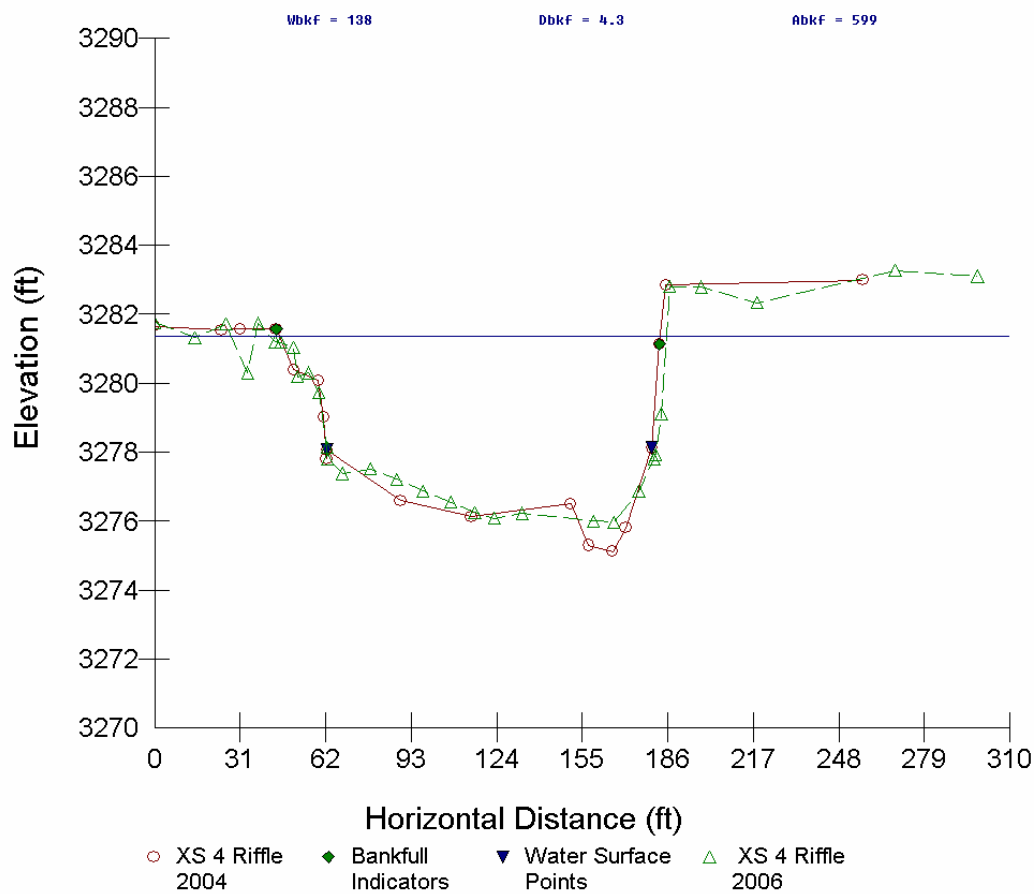
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: High

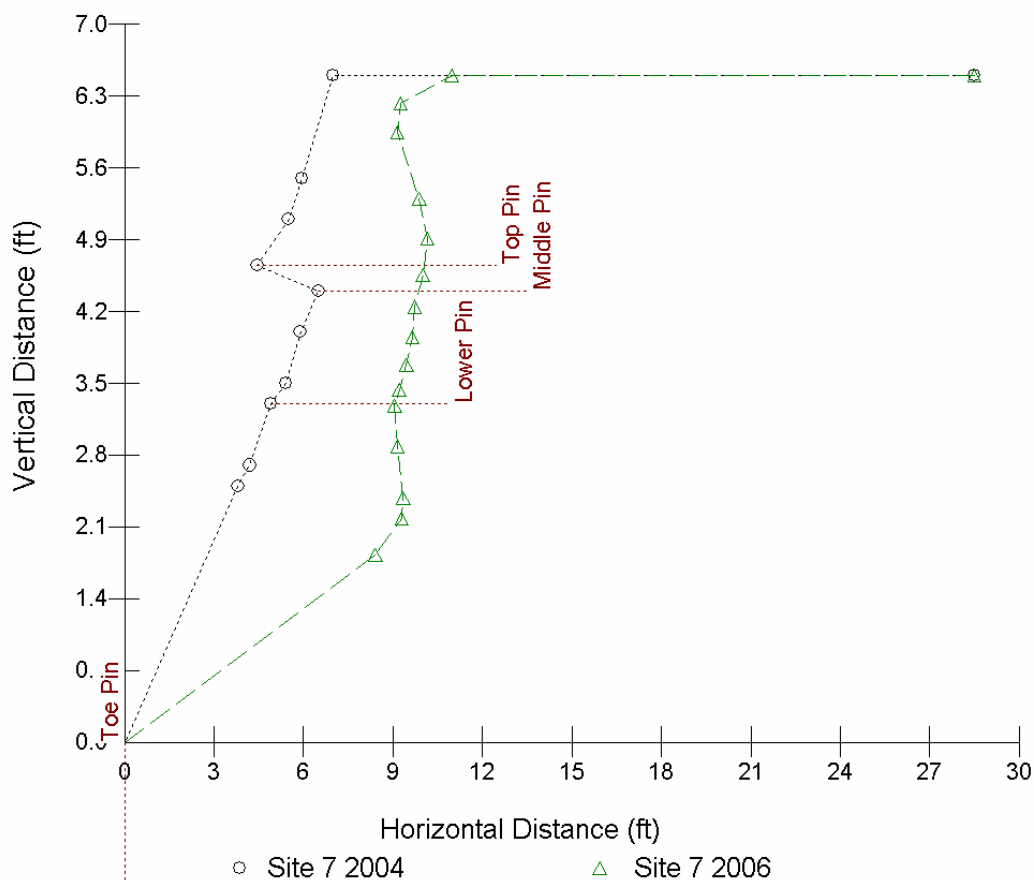
BEHI Numerical Rating: 42.1
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: High
Total Bank Length: 561 ft
Estimated Sediment Loss: 52.15 Cu Yds per Year
Estimated Sediment Loss: 67.8 Tons per Year



Site 6 in 2004 (left) and 2006 (right).



Cross-section 4 in the vicinity of Site 6 (2004 and 2006 surveys).

Site: 7**Erodability Rating: Moderate Near Bank Stress: Moderate**

2004 and 2006 bank profiles at Site 7 in CFR 3B.

Site 7 Measured Bank Erosion (in ft)						
Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	7.0	8.9	9.3	1.9	0.4	2.3
Top Pin	4.5	9.3	10.0	4.9	0.7	5.6
Middle Pin	6.5	8.9	9.7	2.4	0.8	3.2
Lower Pin	4.9	8.5	9.1	3.6	0.6	4.2
Toe of Bank	3.8	7.6	9.4	3.8	1.7	5.5
Average Change				3.3	0.8	4.1

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 B Reference
BEHI Name: Bankpin Site 7
Survey Date: 09/13/06

Bankfull Height: 5 ft
Bank Height: 6.7 ft
Root Depth: 3 ft
Root Density: 40 %
Bank Angle: 90 Degrees
Surface Protection: 40 %

Bank Material Adjustment: Gravel 0

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #5: Ratio of Near-Bank Maximum Bankfull Depth to
Mean Bankfull Depth

NB Max Depth: 5.48 ft Mean Depth: 3.28 ft
Ratio: 1.67

BEHI Numerical Rating: 29.8
BEHI Adjective Rating: Moderate
NBS Numerical Rating: 1.67
NBS Adjective Rating: Moderate
Total Bank Length: 1973 ft
Estimated Sediment Loss: 1620.56 Cu Yds per Year
Estimated Sediment Loss: 2106.73 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 B Reference
BEHI Name: Bankpin Site 7
Survey Date: 09/13/06

Bankfull Height: 5 ft
Bank Height: 6.7 ft
Root Depth: 3 ft
Root Density: 40 %
Bank Angle: 90 Degrees
Surface Protection: 40 %

Bank Material Adjustment: Gravel 0

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Colorado

NBS Method #5: Ratio of Near-Bank Maximum Bankfull Depth to
Mean Bankfull Depth

NB Max Depth: 5.48 ft Mean Depth: 3.28 ft
Ratio: 1.67

BEHI Numerical Rating: 29.8
BEHI Adjective Rating: Moderate
NBS Numerical Rating: 1.67
NBS Adjective Rating: Moderate
Total Bank Length: 1973 ft
Estimated Sediment Loss: 93.02 Cu Yds per Year
Estimated Sediment Loss: 120.93 Tons per

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3B
BEHI Name: Site 7 2006
Survey Date: 08/23/06

Bankfull Height: 3.4 ft
Bank Height: 4.4 ft
Root Depth: 3 ft
Root Density: 30 %
Bank Angle: 100 Degrees
Surface Protection: 35 %

Bank Material Adjustment: Cobble -5

Bank Stratification Adjustment: Yes 5

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Moderate

BEHI Numerical Rating: 28.6
BEHI Adjective Rating: Moderate
NBS Numerical Rating: 0
NBS Adjective Rating: Moderate
Total Bank Length: 1973 ft
Estimated Sediment Loss: 266.87 Cu Yds per Year
Estimated Sediment Loss: 346.93 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3B
BEHI Name: Site 7 2006
Survey Date: 08/23/06

Bankfull Height: 3.4 ft
Bank Height: 4.4 ft
Root Depth: 3 ft
Root Density: 30 %
Bank Angle: 100 Degrees
Surface Protection: 35 %

Bank Material Adjustment: Cobble -5

Bank Stratification Adjustment: Yes 5

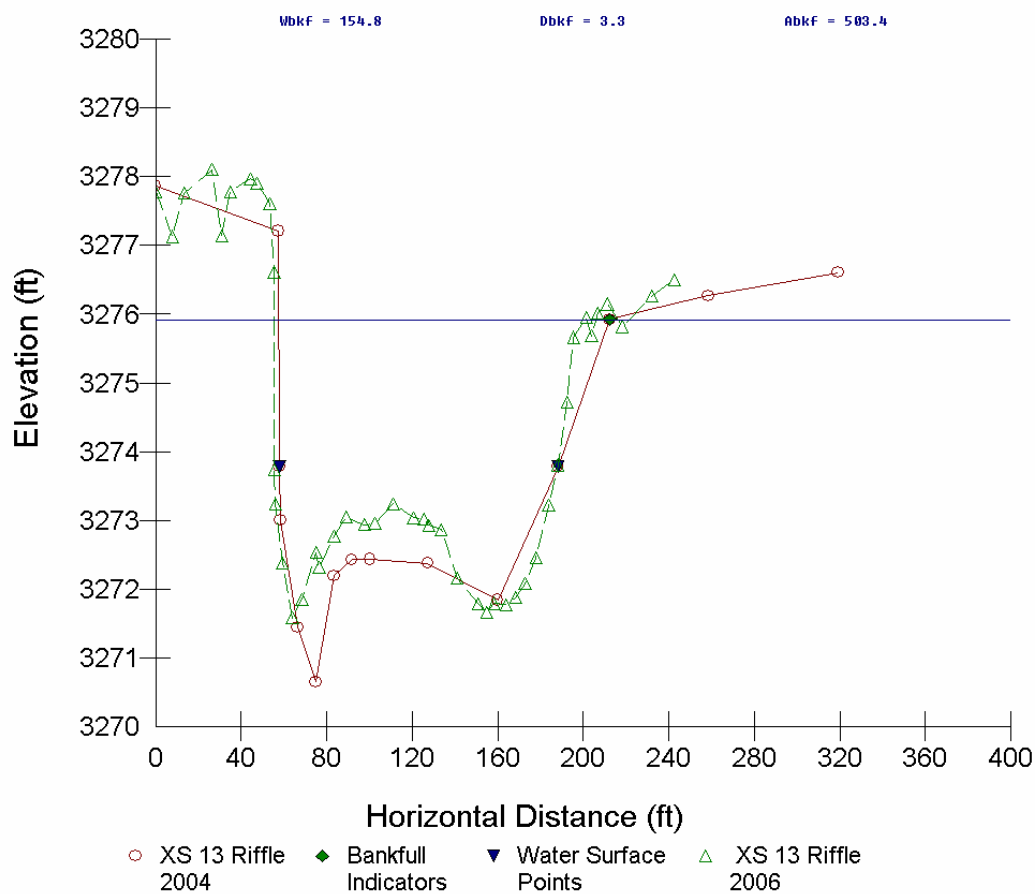
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Moderate

BEHI Numerical Rating: 28.6
BEHI Adjective Rating: Moderate
NBS Numerical Rating: 0
NBS Adjective Rating: Moderate
Total Bank Length: 1973 ft
Estimated Sediment Loss: 61.09 Cu Yds per Year
Estimated Sediment Loss: 79.42 Tons per Year



Site 7 in 2004 (left) and 2006 (right).



Cross-section 13 in the vicinity of Site 7 (2004 and 2006 surveys).

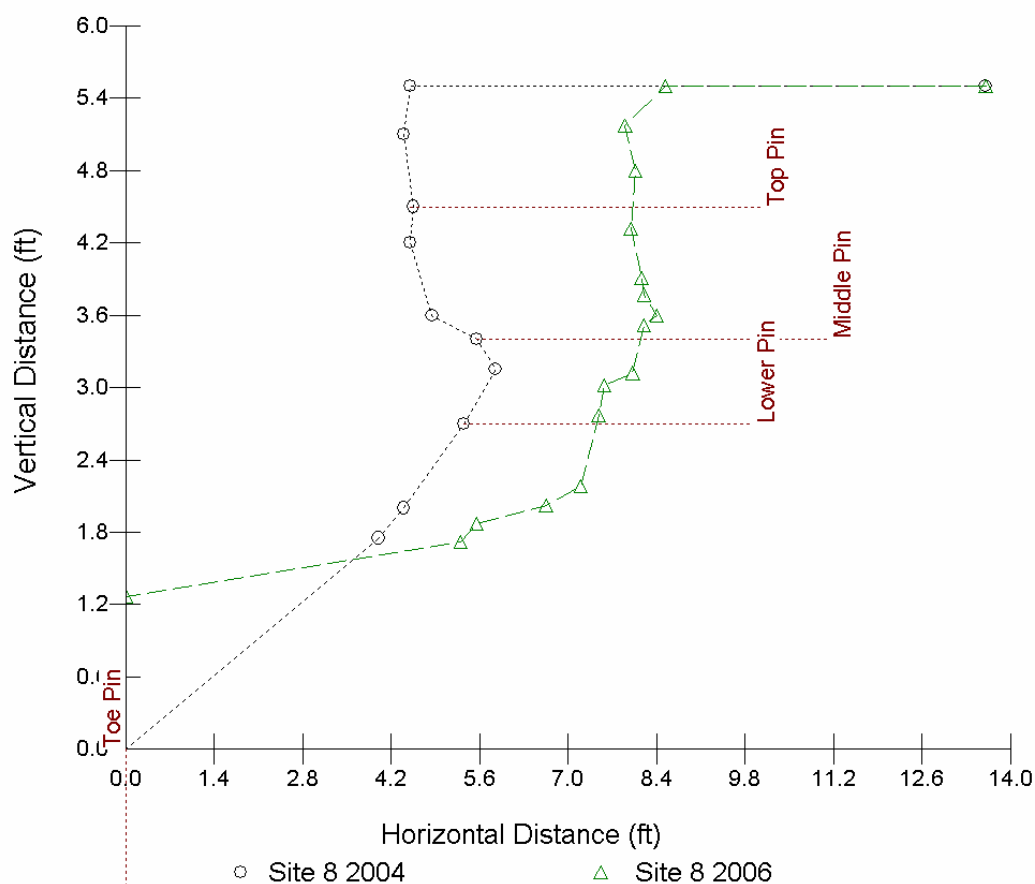
Reach CFR 3C

**Predicted and Measured Bank Erosion Summary Table
2004-2005**

CFR 3C		Predicted erosion (tons/yr)		Measured	
Site	Bank Length (ft)	Yellowstone Data	Colorado Data	ft/yr	tons/yr
8	4702	3113	1619	1.7	2117
9	3218	1343	632	3.5	2750
10	2388	762	358	1.2	520
11	222	17	7	0.2	8
Total	10530	5234.8	2616		5395
Percent of Measured		97	49		

**Predicted and Measured Bank Erosion Summary Table
2005-2006**

CFR 3C		Predicted erosion (tons/yr)		Measured	
Site	Bank Length (ft)	Yellowstone Data	Colorado Data	ft/yr	tons/yr
8	4702	2377	1236	1	951
9	3218	1054	496	2.9	1797
10	2388	567	267	1.1	377
11	222	16.8	7	0.6	21
Total	10530	4015	2006		3146
Percent of Measured		128	64		

Site: **8**Erodability Rating: **Very High** Near Bank Stress: **Extreme**

2004 and 2006 bank profiles at Site 8 in CFR 3C

Site 8 Measured Bank Erosion (in ft)						
Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	4.5	7.0	8.5	2.5	1.6	4.0
Top Pin	4.6	8.0	8.1	3.5	0.1	3.5
Middle Pin	5.6	7.8	8.1	2.3	0.3	2.6
Lower Pin	5.4	6.0	7.5	0.7	1.5	2.1
Toe of Bank	4.0	3.7	5.3	-0.3	1.6	1.3
Average Change				1.7	1.0	2.7

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 C
BEHI Name: Bankpin Site 8
Survey Date: 09/13/06

Bankfull Height: 4.8 ft
Bank Height: 5.5 ft
Root Depth: 0.5 ft
Root Density: 10 %
Bank Angle: 110 Degrees
Surface Protection: 10 %

Bank Material Adjustment: Sand 5

Bank Stratification Adjustment: Yes 1

Erosion Loss Curve: Yellowstone

NBS Method #2: Ratio of Radius of Curvature to Bankfull Width

Radius of Curvature: 203 ft Bankfull Width: 136 ft
Ratio: 1.49 psf

BEHI Numerical Rating: 45.2
BEHI Adjective Rating: Very High
NBS Numerical Rating: 1.49
NBS Adjective Rating: Extreme
Total Bank Length: 4702 ft
Estimated Sediment Loss: 1628.29 Cu Yds per Year
Estimated Sediment Loss: 2116.78 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 C
BEHI Name: Bankpin Site 8
Survey Date: 09/13/06

Bankfull Height: 4.8 ft
Bank Height: 5.5 ft
Root Depth: 0.5 ft
Root Density: 10 %
Bank Angle: 110 Degrees
Surface Protection: 10 %

Bank Material Adjustment: Sand 5

Bank Stratification Adjustment: Yes 1

Erosion Loss Curve: Colorado

NBS Method #2: Ratio of Radius of Curvature to Bankfull Width

Radius of Curvature: 203 ft Bankfull Width: 136 ft
Ratio: 1.49 psf

BEHI Numerical Rating: 45.2
BEHI Adjective Rating: Very High
NBS Numerical Rating: 1.49
NBS Adjective Rating: Extreme
Total Bank Length: 4702 ft
Estimated Sediment Loss: 1245.16 Cu Yds per Year
Estimated Sediment Loss: 1618.71 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3C
BEHI Name: Site 8 2006
Survey Date: 08/23/06

Bankfull Height: 3.6 ft
Bank Height: 4.2 ft
Root Depth: 1 ft
Root Density: 5 %
Bank Angle: 80 Degrees
Surface Protection: 1 %

Bank Material Adjustment: Sand 6

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Extreme

BEHI Numerical Rating: 42.0
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: Extreme
Total Bank Length: 4702 ft
Estimated Sediment Loss: 731.42 Cu Yds per Year
Estimated Sediment Loss: 950.85 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3C
BEHI Name: Site 8 2006
Survey Date: 08/23/06

Bankfull Height: 3.6 ft
Bank Height: 4.2 ft
Root Depth: 1 ft
Root Density: 5 %
Bank Angle: 80 Degrees
Surface Protection: 1 %

Bank Material Adjustment: Sand 6

Bank Stratification Adjustment: None 0

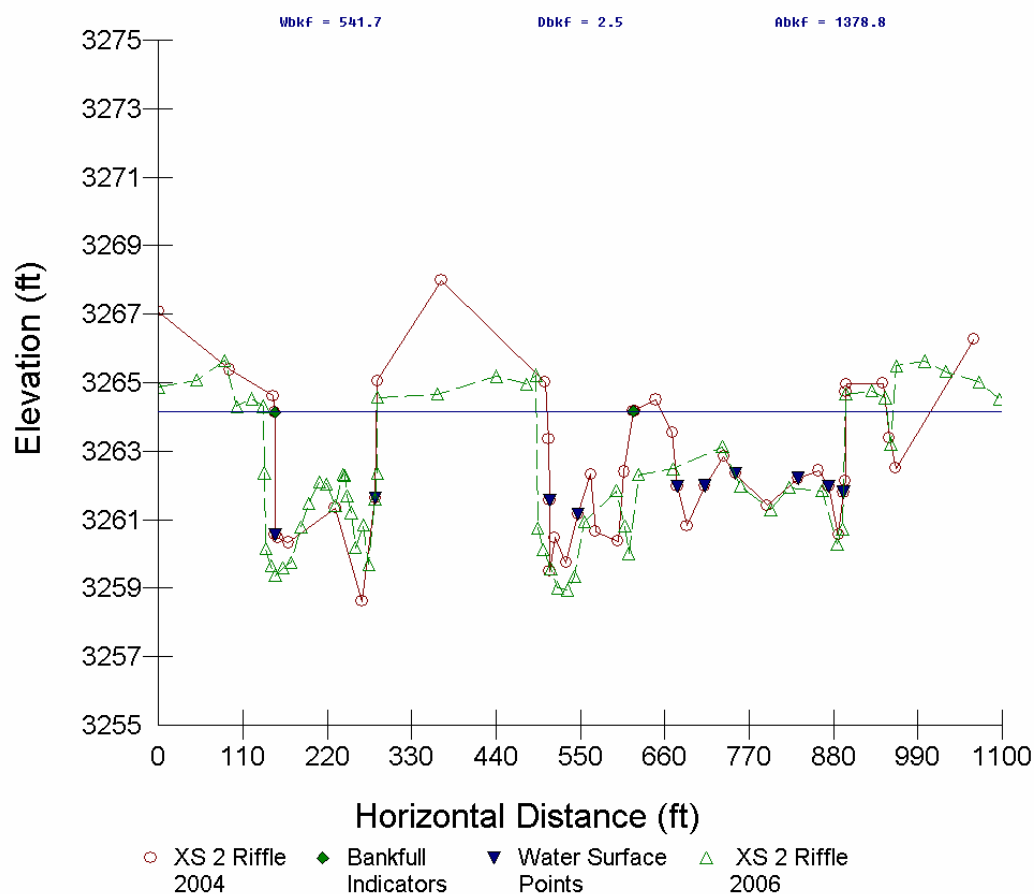
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Extreme

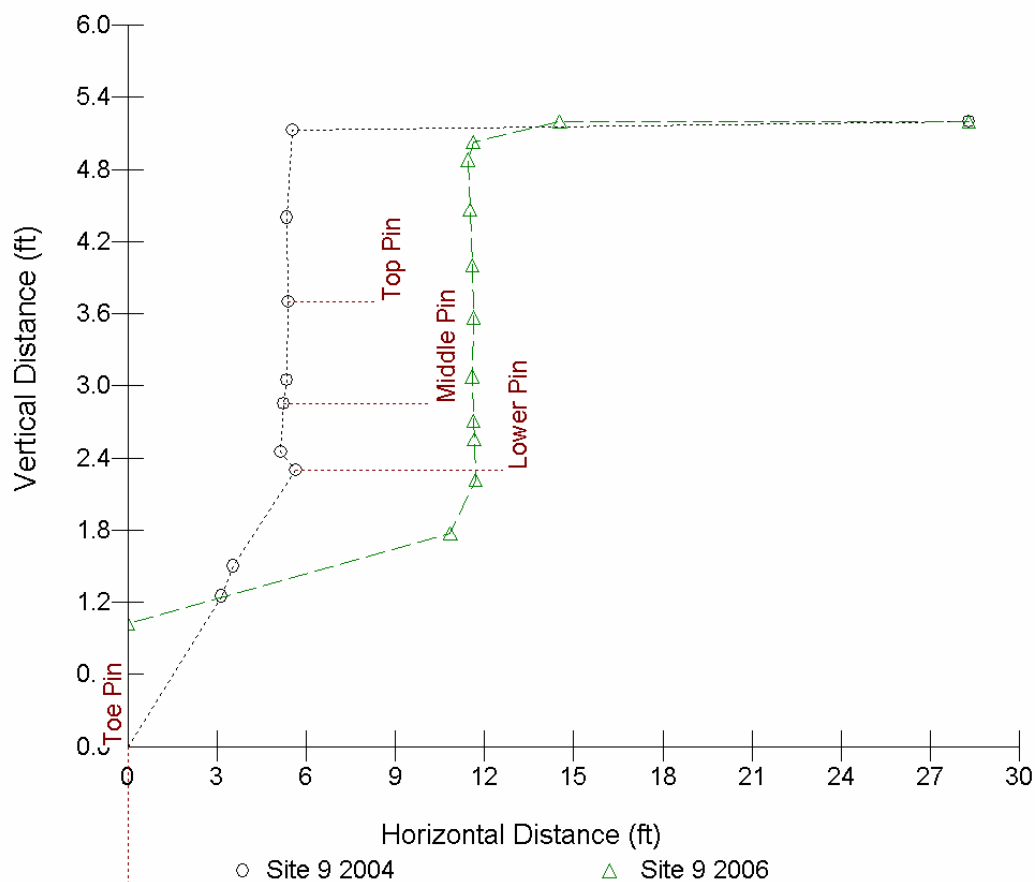
BEHI Numerical Rating: 42.0
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: Extreme
Total Bank Length: 4702 ft
Estimated Sediment Loss: 950.85 Cu Yds per Year
Estimated Sediment Loss: 1236.11 Tons per Year



Site 8 in 2004 (left) and 2006 (right).



Cross-section 2 in the vicinity of Site 8 (2004 and 2006 surveys).

Site: 9**Erodability Rating: Very High Near Bank Stress: Very High**

2004 and 2006 bank profiles at Site 9 in CFR 3C

Site 9 Measured Bank Erosion (in ft)						
Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	5.6	8.1	11.7	2.6	3.6	6.2
Top Pin	5.4	8.9	11.6	3.5	2.7	6.2
Middle Pin	5.3	8.9	11.6	3.7	2.7	6.3
Lower Pin	5.7	8.6	11.7	3.0	3.1	6.0
Toe of Bank	3.6	8.3	10.9	4.8	2.6	7.3
Average Change				3.5	2.9	6.4

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 C
BEHI Name: Bankpin Site 9
Survey Date: 09/13/06

Bankfull Height: 4.3 ft
Bank Height: 5.1 ft
Root Depth: 0.5 ft
Root Density: 17.5 %
Bank Angle: 100 Degrees
Surface Protection: 15 %

Bank Material Adjustment: Gravel 3

Bank Stratification Adjustment: Yes 2

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Very High

BEHI Numerical Rating: 43.6
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 3218 ft
Estimated Sediment Loss: 2115.3 Cu Yds per Year
Estimated Sediment Loss: 2749.89 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 C
BEHI Name: Bankpin Site 9
Survey Date: 09/13/06

Bankfull Height: 4.3 ft
Bank Height: 5.1 ft
Root Depth: 0.5 ft
Root Density: 17.5 %
Bank Angle: 100 Degrees
Surface Protection: 15 %

Bank Material Adjustment: Gravel 3

Bank Stratification Adjustment: Yes 2

Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Very High

BEHI Numerical Rating: 43.6
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 3218 ft
Estimated Sediment Loss: 486.28 Cu Yds per Year
Estimated Sediment Loss: 632.16 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3C
BEHI Name: Site 9 2006
Survey Date: 08/23/06

Bankfull Height: 3.5 ft
Bank Height: 4 ft
Root Depth: 0.75 ft
Root Density: 5 %
Bank Angle: 85 Degrees
Surface Protection: 2.5 %

Bank Material Adjustment: Sand 3

Bank Stratification Adjustment: Yes 5

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Very High

BEHI Numerical Rating: 44.9
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 3218 ft
Estimated Sediment Loss: 1382.55 Cu Yds per Year
Estimated Sediment Loss: 1797.32 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3C
BEHI Name: Site 9 2006
Survey Date: 08/23/06

Bankfull Height: 3.5 ft
Bank Height: 4 ft
Root Depth: 0.75 ft
Root Density: 5 %
Bank Angle: 85 Degrees
Surface Protection: 2.5 %

Bank Material Adjustment: Sand 3

Bank Stratification Adjustment: Yes 5

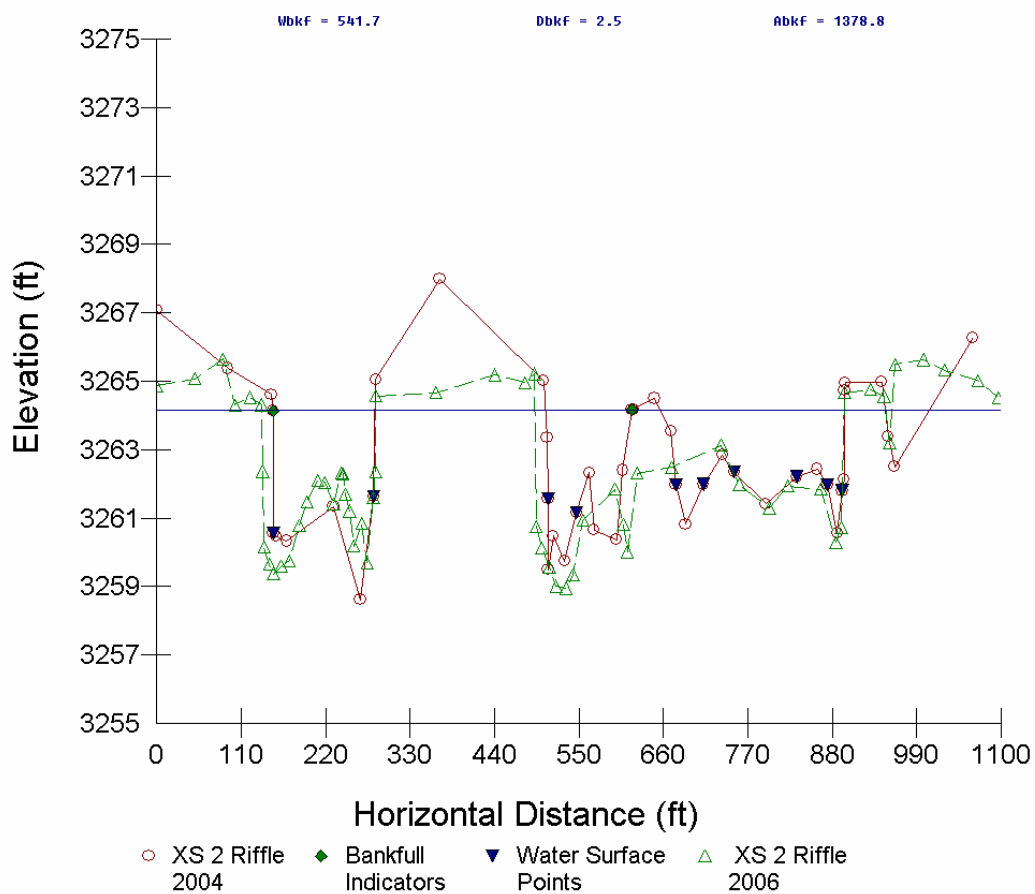
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Very High

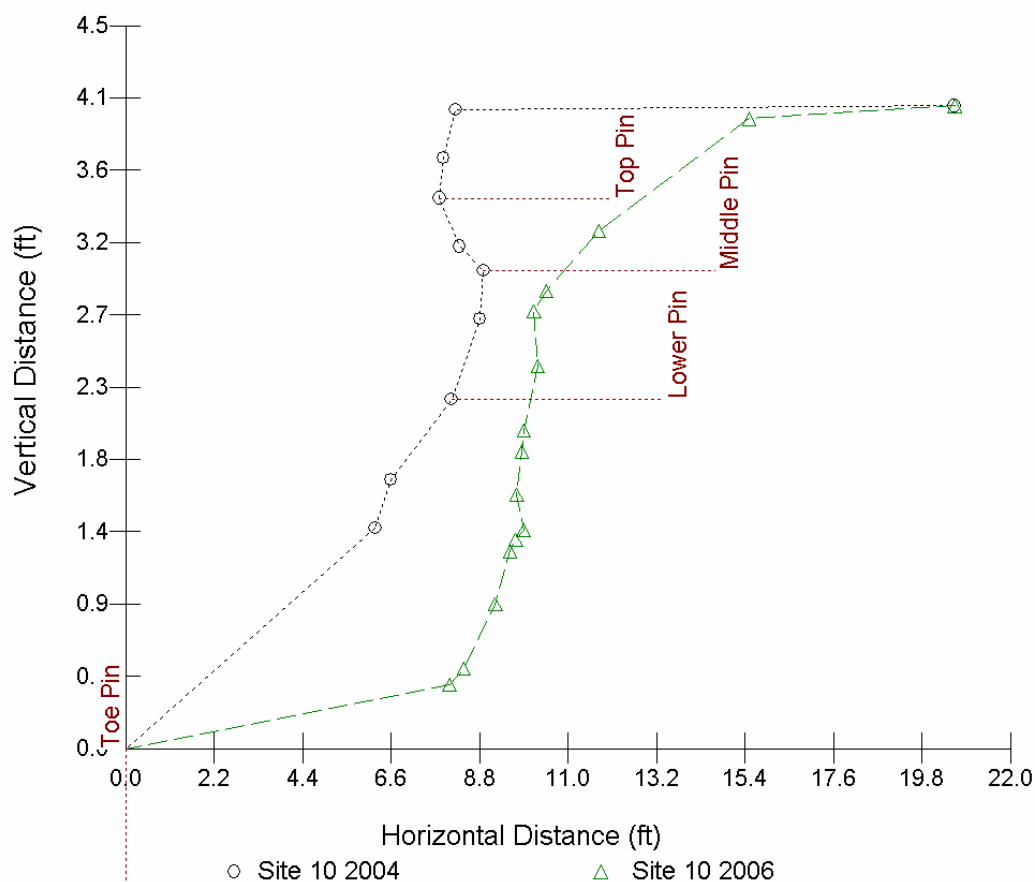
BEHI Numerical Rating: 44.9
BEHI Adjective Rating: Very High
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 3218 ft



Site 9 in 2004 (left) and 2006 (right).



Cross-section 2 in the vicinity of Site 9 (2004 and 2006 surveys).

Site: 10**Erodability Rating: High****Near Bank Stress: Very High**

2004 and 2006 bank profiles at Site 10 in CFR 3C

Site 10 Measured Bank Erosion (in ft)						
Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	8.2	10.1	11.8	1.9	1.7	3.6
Top Pin	7.8	9.3	10.2	1.5	0.9	2.4
Middle Pin	8.9	9.1	10.2	0.2	1.1	1.3
Lower Pin	8.1	8.1	9.7	0.0	1.6	1.6
Toe of Bank	6.6	8.8	9.2	2.2	0.4	2.6
Average Change				1.2	1.1	2.3

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 C
BEHI Name: Bankpin Site 10
Survey Date: 09/13/06

Bankfull Height: 3.9 ft
Bank Height: 3.9 ft
Root Depth: 0.5 ft
Root Density: 27 %
Bank Angle: 100 Degrees
Surface Protection: 30 %

Bank Material Adjustment: Gravel 0

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Very High

BEHI Numerical Rating: 33.3
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 2388 ft
Estimated Sediment Loss: 400.12 Cu Yds per Year
Estimated Sediment Loss: 520.16 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 C
BEHI Name: Bankpin Site 10
Survey Date: 09/13/06

Bankfull Height: 3.9 ft
Bank Height: 3.9 ft
Root Depth: 0.5 ft
Root Density: 27 %
Bank Angle: 100 Degrees
Surface Protection: 30 %

Bank Material Adjustment: Gravel 0

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Very High

BEHI Numerical Rating: 33.3
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 2388 ft
Estimated Sediment Loss: 275.95 Cu Yds per Year
Estimated Sediment Loss: 358.74 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3C
BEHI Name: Site 10 2006
Survey Date: 08/23/06

Bankfull Height: 2.9 ft
Bank Height: 2.9 ft
Root Depth: 1.4 ft
Root Density: 45 %
Bank Angle: 50 Degrees
Surface Protection: 15 %

Bank Material Adjustment: Sand 5

Bank Stratification Adjustment: Yes 5

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Very High

BEHI Numerical Rating: 33.4
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 2388 ft
Estimated Sediment Loss: 289.83 Cu Yds per Year
Estimated Sediment Loss: 376.78 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3C
BEHI Name: Site 10 2006
Survey Date: 08/23/06

Bankfull Height: 2.9 ft
Bank Height: 2.9 ft
Root Depth: 1.4 ft
Root Density: 45 %
Bank Angle: 50 Degrees
Surface Protection: 15 %

Bank Material Adjustment: Sand 5

Bank Stratification Adjustment: Yes 5

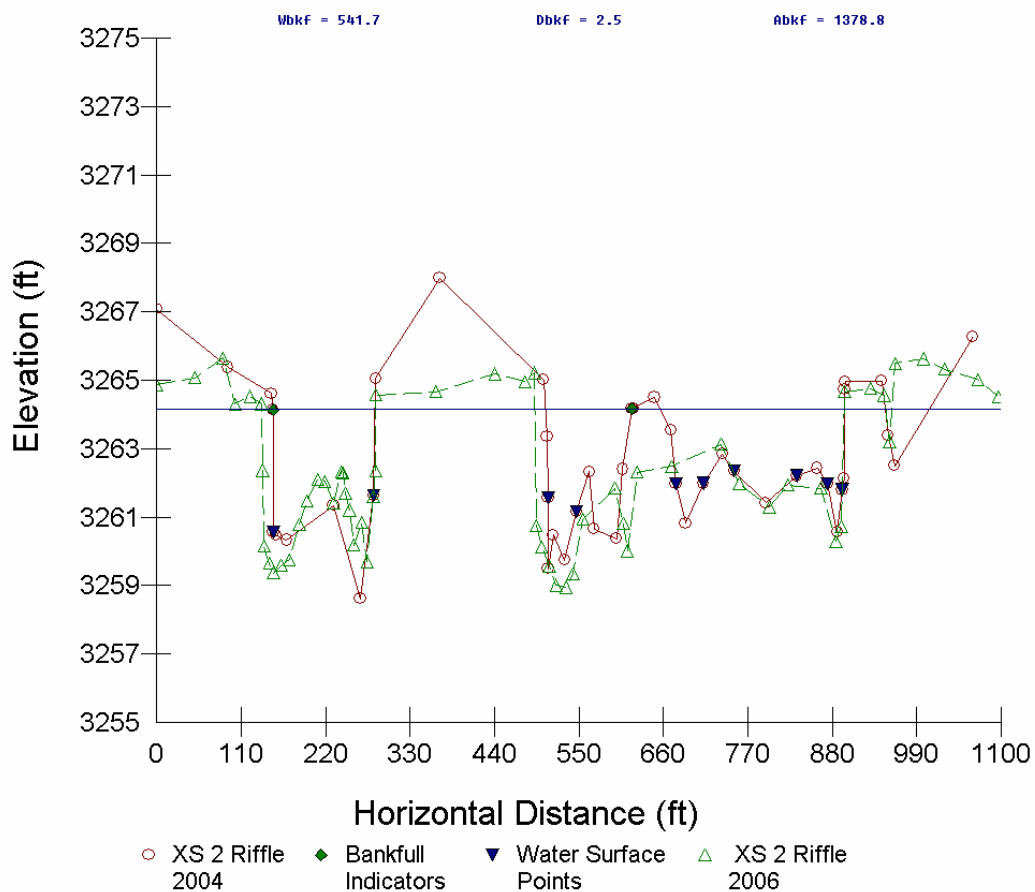
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Very High

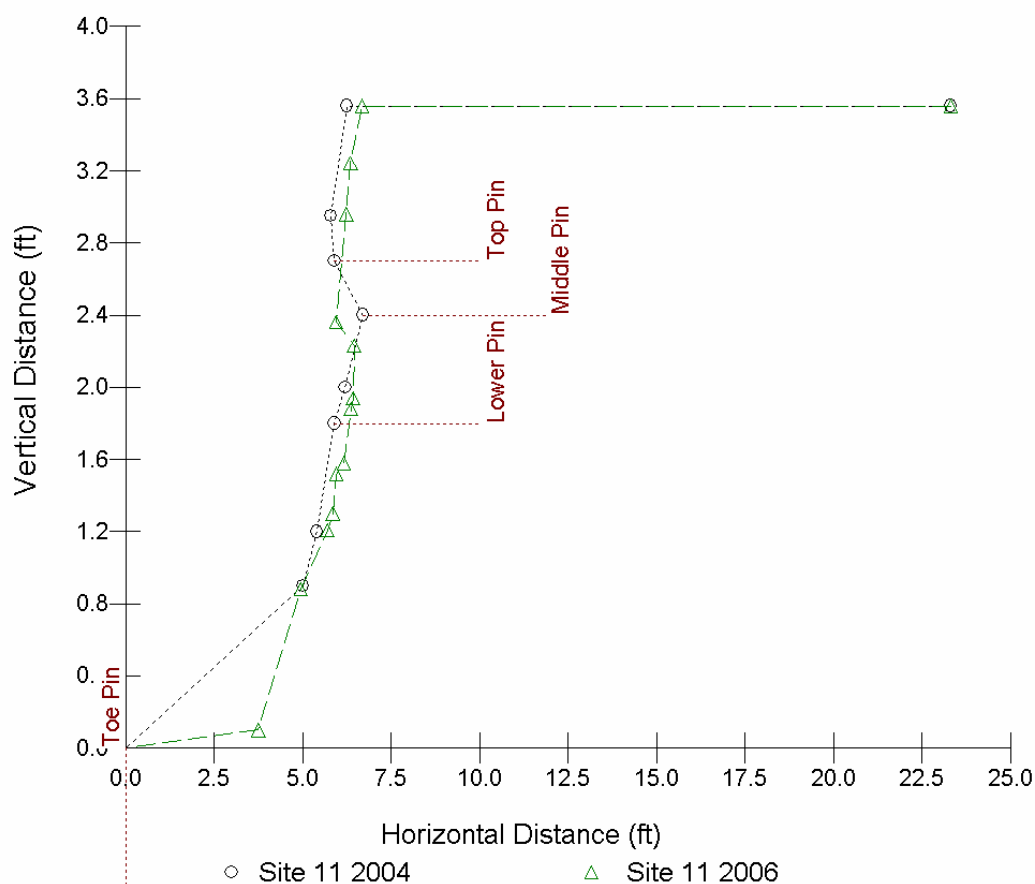
BEHI Numerical Rating: 33.4
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 2388 ft
Estimated Sediment Loss: 205.19 Cu Yds per Year
Estimated Sediment Loss: 266.75 Tons per Year



Site 10 in 2004 (left) and 2006 (right).



Cross-section 2 in the vicinity of Site 10 (2004 and 2006 surveys).

Site: **11**Erodability Rating: **High**Near Bank Stress: **Low**

2004 and 2006 bank profiles at Site 11 in CFR 3C

Site 11 Measured Bank Erosion (in ft)						
Distance from toe pin (ft)	2004	2005	2006	Change 2004-2005	Change 2005-2006	Change 2004-2006
Top of Bank	6.3	6.5	6.7	0.3	0.2	0.4
Top Pin	5.9	6.0	6.2	0.1	0.2	0.3
Middle Pin	6.7	5.9	6.0	-0.8	0.1	-0.7
Lower Pin	5.9	4.0	6.4	-1.2	1.7	0.5
Toe of Bank	5.0	4.6	5.3	-0.4	0.7	0.3
Average Change				-0.4	0.6	0.2

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 C
BEHI Name: Bankpin Site 10
Survey Date: 09/13/06

Bankfull Height: 3.9 ft
Bank Height: 3.9 ft
Root Depth: 0.5 ft
Root Density: 27 %
Bank Angle: 100 Degrees
Surface Protection: 30 %

Bank Material Adjustment: Gravel 0

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Very High

BEHI Numerical Rating: 33.3
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: Very High
Total Bank Length: 2388 ft
Estimated Sediment Loss: 400.12 Cu Yds per Year
Estimated Sediment Loss: 520.16 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR 2004 GR
Reach Name: CFR3 C
BEHI Name: Bankpin Site 11
Survey Date: 09/13/06

Bankfull Height: 2.9 ft
Bank Height: 3.5 ft
Root Depth: 1.4 ft
Root Density: 40 %
Bank Angle: 100 Degrees
Surface Protection: 40 %

Bank Material Adjustment: Silt/Clay 0

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Colorado

NBS Method #5: Ratio of Near-Bank Maximum Bankfull Depth to
Mean Bankfull Depth

NB Max Depth: 3.66 ft Mean Depth: 3.52 ft
Ratio: 1.04

BEHI Numerical Rating: 30.2
BEHI Adjective Rating: High
NBS Numerical Rating: 1.04
NBS Adjective Rating: Low
Total Bank Length: 222 ft
Estimated Sediment Loss: 5.18 Cu Yds per Year
Estimated Sediment Loss: 6.73 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3C
BEHI Name: Site 11 2006
Survey Date: 08/23/06

Bankfull Height: 3.25 ft
Bank Height: 3.5 ft
Root Depth: 1.5 ft
Root Density: 30 %
Bank Angle: 90 Degrees
Surface Protection: 15 %

Bank Material Adjustment: Silt/Clay 4

Bank Stratification Adjustment: None 0

Erosion Loss Curve: Yellowstone

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Low

BEHI Numerical Rating: 34.3
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: Low
Total Bank Length: 222 ft
Estimated Sediment Loss: 12.95 Cu Yds per Year
Estimated Sediment Loss: 16.84 Tons per Year

RIVERMORPH BANK EROSION HAZARD INDEX (BEHI)

River Name: CFR Aug 2006
Reach Name: CFR 3C
BEHI Name: Site 11 2006
Survey Date: 08/23/06

Bankfull Height: 3.25 ft
Bank Height: 3.5 ft
Root Depth: 1.5 ft
Root Density: 30 %
Bank Angle: 90 Degrees
Surface Protection: 15 %

Bank Material Adjustment: Silt/Clay 4

Bank Stratification Adjustment: None 0

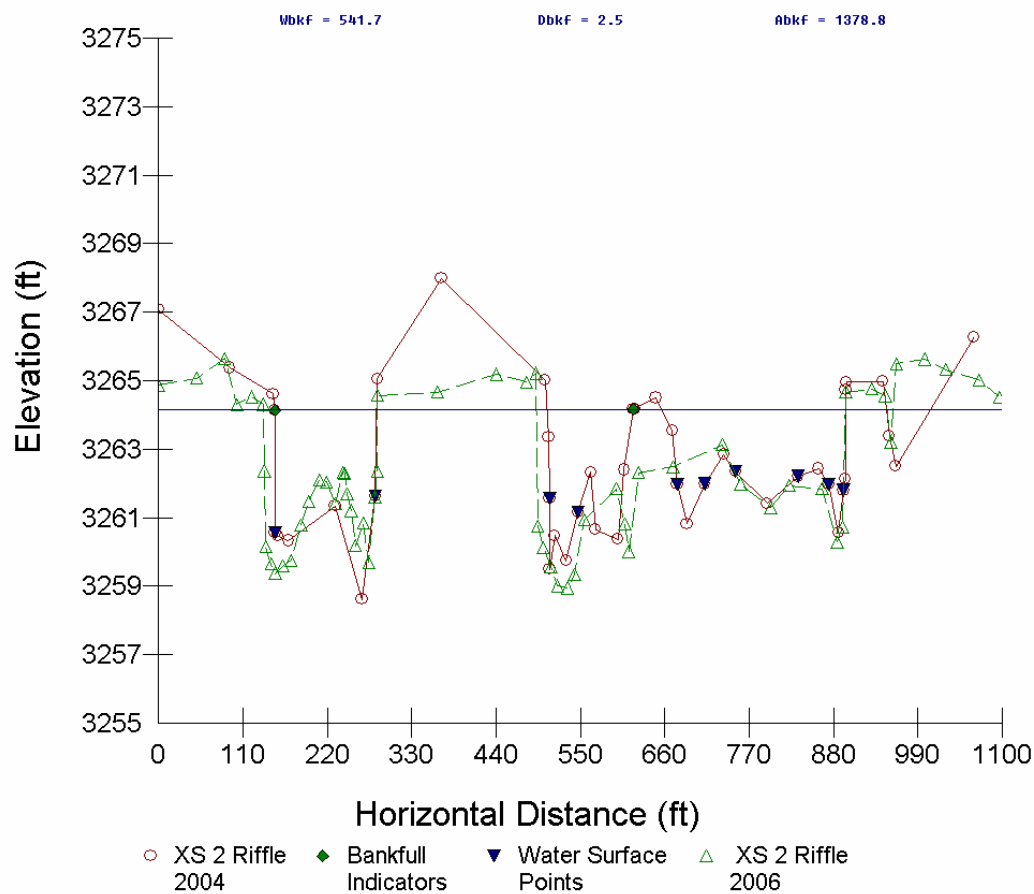
Erosion Loss Curve: Colorado

NBS Method #1: Channel Pattern and/or Depositional Features for
Adjustments in Near-Bank Stress
Rating: Low

BEHI Numerical Rating: 34.3
BEHI Adjective Rating: High
NBS Numerical Rating: 0
NBS Adjective Rating: Low
Total Bank Length: 222 ft
Estimated Sediment Loss: 5.18 Cu Yds per Year
Estimated Sediment Loss: 6.73 Tons per Year



Site 11 in 2006 looking downstream (left) and upstream (right).



Cross-section 2 in the vicinity of Site 11 (2004 and 2006 surveys).